

THE MEDIEVAL CANNON 1326–1494



JONATHAN DAVIES

ILLUSTRATED BY A. HOOK,
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NEW VANGUARD 273

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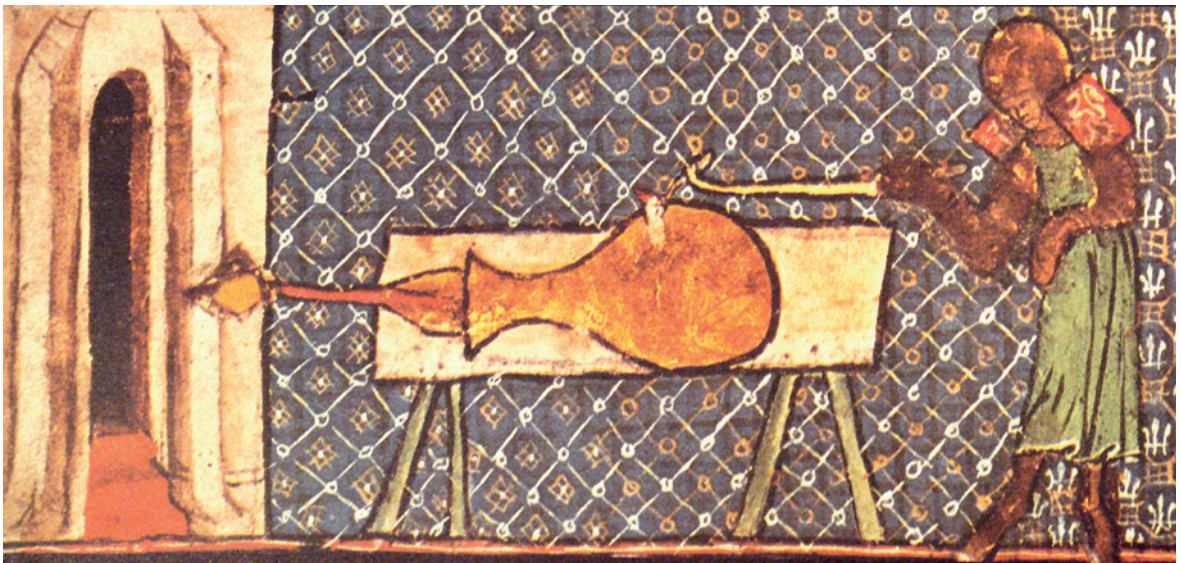
INTRODUCTION

When the ‘Crakys of war’ were first heard on the field of battle, perhaps it seemed that this was also the crack of doom for the traditional form of medieval warfare that had emerged in feudal Christendom. The knight on horseback and the lord in his castle were now to become the victims of an expensive and diabolical technology which would revolutionize warfare. However, gunpowder weapons of this period have been often derided as little more than expensive toys, as dangerous to their crews as to their enemies, of more use as status symbols than as weapons of war. Agincourt was won by the longbow, not the cannon, and no ship was sunk by artillery fire until the battle of Zonchio in 1499. Where lies the truth – did gunpowder revolutionize, transform or merely change the nature of warfare?

This illustration from the Milemete manuscript has, as we shall see, been subject to a variety of interpretations. What is undoubtedly the case is that it is the first illustration of a cannon. (Walter de Milemete/ Wikimedia Commons / Public Domain)

The origins of cannons in Christendom

The most convincing early record of gunpowder weapons is from a Florentine document of 1326. This was an order for iron bullets, metal cannon and gunpowder which was given to the man designated as the Master of





The Loshult gun is only 30cm long with a bore of 36mm, or almost 1½in, and weighs a little over 9kg. The interior of the barrel shows striations, which suggest that it was used for firing iron shrapnel, a practice which would have proved very effective, as recent trials have shown. (Gunnel Jansson, National Historical Museums, Sweden)

Bombards. That there was such an official would suggest that such weapons had already been in use for some time.

The first representations of cannons can be found in two English manuscripts. The first is *Secretum Secretorum et Prudentiis Regum* and the second *De Notabilibus, sapientiis et prudentiis regum* (Concerning the Majesty, Wisdom and Prudence of Kings). Both were ordered by Walter de Milemete, King's clerk, and presented to Edward III at some time between the end of 1326 and March 1327. The former is known as the Holkham manuscript and the latter the Milemete. The guns illustrated in both the Holkham and the Milemete manuscripts were vase-shaped and clearly cast from bronze.

A small, vase-shaped cannon of this period was discovered by a farmer in Loshult Skåna, Sweden, in 1861. Unfortunately, the cannon lacks an archaeological context, but has been dated tentatively to around 1340. There was another vase-shaped gun from Mantua, northern Italy, dated to 1322 and now unfortunately lost, but which was carefully measured in 1786. Its length was 16.4cm, with a calibre of 5.5cm and a weight of just under 5kg. It seems in many respects to have been a half-size version of the Loshult cannon, but with a larger bore.

The Milemete weapons are pretty much fully developed and entirely practical, except for their dimensions. The use of bronze as a material was a sound choice: the reinforcement at the mouth and breech showed an understanding of the stresses and strains they would be subject to, and the gun arrow, or 'garros', shown in both was certainly effective. That the vase shape was successful and continued to be used is apparent from a similar cannon in a copy of the *Chroniques de St. Denis*, of 1390–1420.

If the cannon emerged fully formed in the West in the early 14th century, it is almost certainly the consequence of technological transmission from East to West rather than Western parallel development. China, where gunpowder originated probably in the

An illustration from the *Krieg Technik* of the 1420–40s. The flights of the garros, or gun arrow, are clearly made from metal and the shaft appears to be laid along a piece of timber in front of the muzzle perhaps to ensure a straight flight. It is perhaps surprising to see a garros still illustrated more than a century after the first illustration of a cannon. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.125r)



mid-11th century, was almost certainly where not only incendiary and explosive projectiles developed, but also guns. The Yuan cannon, the earliest identifiable gun, is dated to 1322 and demonstrates the bulbous combustion chamber and straight bore associated with early Western examples. The route of transmission would seem, as with most technological advances, to have been through the Arab world, probably through the violent interface between Islam and Christianity that was the Iberian Peninsula in the age of the *Reconquista* (the campaigns to oust the Moors). The earliest reference on the Iberian Peninsula to gunpowder weapons is during the siege of Huescar in 1324, and in 1325 there is mention of ‘Thunder machines’ – clearly pointing to the principal impact these new weapons had on observers.

The first use of artillery in Christendom is also attributed to the English, in 1327. Archdeacon John Barbour of Aberdeen, in his heroic poem *Brus*, referred to the use of ‘*Crakys of wer*’ by Edward III against the Scots. However, as Barbour was only seven when these events took place and the poem was written about 50 years after the event, it cannot be considered proof of the use of artillery. It is almost certain that English guns were present at the battle of Crecy in 1346: inventories of weapons and contemporary accounts all suggest that guns played a part.

The number and variety of references to both gunpowder and weapons increase considerably in the 1330s and 1340s. For example, preparation for the defence of Cambrai in 1339 against Edward III included the provision of five iron and five copper alloy cannons. It is interesting to note that the Cambrai guns were constructed of both metals, suggesting that very early on the possibility of using wrought iron as a material was being exploited. This could have been done with simple forging, as a Loshult-style gun could certainly have been made from a single bloom of wrought iron. The French use of the term *pots de fer* to describe early guns would also suggest that iron was considered as the principal metal for their manufacture quite early on. By the 1340s there are so many references to gunpowder weapons that they had clearly ceased to be a novelty and were now considered a natural accompaniment to warfare. This is apparent when considering the condemnation of gunpowder weapons by Petrarch in 1344:

The anger of immortal God thundering from the heavens was not enough, even for little Man. From the earth it even had to boom out... Until recently this was such a rare scourge that it was considered a phenomenon. Now as peaceful minds are a match for the most dire circumstances, it is as common as any type of arms.

That by the middle of the 14th century guns became fairly commonplace items in the conduct of war is clear. With use came misuse. The first decidedly negligent discharge can be dated quite precisely to 1346 in Tournai, in modern Belgium, where a cannon made by Peter of Bruges ‘made such a cruel and loud noise that the quarrel [garros] went through the town ... and passed the two walls of the town ... and struck a man ... on the head and killed him’.

The guns themselves do not seem to have grown greatly in either size or number in this early period. The price of a small cannon in England in 1355 was 13s 4d, whereas a large crossbow cost 66s 8d, more than five times as much. In 1365 there was only one small gun recorded in the Tower

THE MILEMETE GUN

The Milemete cannon is one of the most discussed and least-understood pieces of ordnance in history. Much debate surrounds this drawing (see page 4)– was the bore a simple tube or did it mimic the exterior of the gun in form? Was the arrow emerging from the gun or was it about to be fired, and were the visible flights the only ones or were there more to be found further along the shaft, making the bore the same width as the flights? The contemporary description of gun arrows, their discovery in Burg Elz and practical trials have answered some of these questions.

In 1999 the Royal Armouries constructed a full-scale bronze replica, using the gunner depicted for scale. The result was a very heavy gun weighing some 410kg with a bore of 38mm, and the thickness of metal at the breech was 181mm. To compare, the Loshult cannon, with a bore of 36mm, weighs a little over 9kg, with the thickness of metal at the breech only 37mm. The Royal Armouries version initially used charges of 113–454g of modern powder, which shattered the 1.35m-long garros shaft. Only when they used a charge of just 57g was the shaft fired undamaged. The Armouries weapon would have cost at least £50 in metal alone at contemporary prices.

The purpose of the illustration seems to have been to show the principal features of the weapon rather than to be a precise drawing.



The Holkham manuscript gun is larger than the Milemete example and ignited from a touch hole to the rear of the breech. It appears to have a larger crew or audience standing in awe or expectation. The noise from the earliest guns must have been as important as their projectiles to those who encountered them for the first time. (British Library, London, UK© British Library Board. All Rights Reserved/Bridgeman Images)

of London, in 1371 six guns were sent to Dover Castle, and in the 1372 expedition to France some 29 iron guns were sent. Richard II purchased small iron cannons for between 20s and 26s 8d, and what was described as a ‘Great copper cannon’ for £3, which would suggest that at contemporary prices, guns were weighing less than 45kg each.

After 1382 there was a renewed interest in the acquisition of artillery under Randolph Hatton, the Keeper of the Privy Wardrobe from 1382 to 1396. William Byker, for example, cast 43 copper alloy guns, each weighing 380lb (172kg) at 4d a pound. Most guns appear to have been cast rather than forged from iron at this point. The transformation of artillery as a significant force was the consequence of a significant reduction in the cost of metal and an even more significant reduction in the cost of saltpetre following the development of domestic saltpetre plantations.

GUNPOWDER

Gunpowder is made from three ingredients: saltpetre (potassium nitrate, KNO_3), sulphur and charcoal. Combined together, usually in the ratio of $7\frac{1}{2}:1:1\frac{1}{2}$, they will produce between 270 and 360cm³ of gas per gram of solid. This gas acts as the propellant for the projectile placed in a barrel. Technically, gunpowder does not explode at all – it deflagrates or burns at speed, although the process is normally completed in milliseconds.

Two of the three constituents, charcoal and sulphur, are relatively easy to source. The simple process of burning wood in the absence of air was used to manufacture charcoal. Willow, alder and birch charcoal were preferred, as their open-pore structure encouraged the absorption of liquid. Yellow rock sulphur occurs naturally as a result of volcanic activity in Europe, in Sicily and Iceland. Saltpetre, on the other hand, was the product of the chemical

THE LOSHULT CANNON

The Loshult cannon has been reconstructed by Peter Vemming at the Danish Middle Ages Centre. In the comprehensive trials that followed it became clear that the gun was far more than a toy. The tests used the full range of wooden arrows and anti-personnel small shot, as well as a lead ball weighing 184g.

The gun was cast on site and then mounted in an oak block, and securely tied and wedged in place. For the majority of trials the gun was loaded with a standard powder charge of 50g. The gun proved remarkably effective, if not necessarily very easy to aim. Elevation of the barrel was difficult to achieve with accuracy, even when using modern equipment. It was clearly a weapon that would be best suited to firing flat along a fixed line. The performance of the arrows was very impressive. All of the wooden quarrels flew well. The rope-bound tail of the arrows was hammered into the muzzle, forming a tight seal, and they left the gun at between 80 and 110m/s (metres per second). It was considered that the 2m-square target set 200m away was in danger.



The Danish reconstruction of the Loshult cannon was tested extensively with a range of ammunition against a variety of targets. The gun arrow seen fitted here flew well and would have been a fearsome sight, approaching its human targets at 320km per hour. (Courtesy of the Middelaldercentret)

The lead ball left the barrel at a higher and more consistent velocity of from 130 to 155m/s. It achieved a range of 620m at fifteen degrees, some three times the range of the quarrels at the same elevation. The maximum range of this type of projectile under trial conditions was 1,200m. The iron dice and flint shrapnel proved remarkably effective, but only at very short range.

The Loshult gun would have proved to be an excellent addition to the late medieval armoury. It could be used with either



The bark and bite of the Loshult cannon belies its size. The two-man crew can be seen loading a scoop with approximately 50g of powder. A relatively high rate of fire of three rounds a minute can be achieved when shooting iron dice, although it is essential to wad the dice securely if they are to be effective. (Courtesy of the Middelaldercentret)

wooden quarrels or lead balls to hit small groups of the enemy at about 200m, with a good chance of doing serious damage to anything it struck. At up to 20m and shooting grapeshot, it could be used to sweep a passageway or control an entrance. It would have been of marginal use in a field engagement, but as a shipboard weapon it might well have proved of great use for sweeping enemy decks before the bloody business of boarding began.

decomposition of animal or human waste, where the ammonium ions in decomposing matter are converted to nitrates by the action of *nitrosomonas* and *nitrobacter* bacteria. India appears to have produced the majority of saltpetre for European consumption, continuing to export large quantities well into the 18th century.

In China, gunpowder was discovered as the by-product of alchemical investigation into nitrates; it was employed for its medicinal, cultural and military uses. It has been argued that the relatively high proportion of

saltpetre in the early Arab and Western recipes would suggest that there was little experimentation, and that a well-known and probably Chinese formula was adopted early on. The claims of the shady German Berthold Schwartz to have invented gunpowder in 1353 cannot be taken seriously, although a statue was erected for him in his home town of Freiburg. Recipes for gunpowder appear in the West and the Arab world in the 13th century. Roger Bacon produced a workable recipe for gunpowder, with a relatively low saltpetre content, in the *Opus Tertium* in 1267, and this is the most reliable date for the first description of gunpowder in the West:

Sed tamen VII Partes Salpetrae, V Partes Coruli et V Partes Sulphuris et sic facies tonitrum et coruscationem, sic scias artificium. (Take 7 parts of saltpetre, 5 parts of hazelwood charcoal and 5 parts of sulphur and that makes thunder and lightning, provided you know the art.)

While there is much scholarly debate concerning Bacon's contribution to the history of gunpowder, he certainly provides an explicit account of gunpowder firecrackers being used by children to annoy adults! His recipe would produce a very low proportion of saltpetre if measured by weight (41 per cent), but a much higher proportion if the measurements were by volume (58 per cent). When test-fired, the former powder proved useless and the latter very successful. Gunpowder can be made without sulphur, but the ignition temperature of the mixture is raised considerably, resulting in misfires.

The economics of gunpowder

The major problem for the West was that the high cost of imported saltpetre made guns an expensive novelty. Thomas de Rolleston purchased saltpetre for the King's Privy Wardrobe in 1347 at 18 pence a pound, and sulphur at eight pence a pound from William of Staines, a spice merchant and the Royal Apothecary. In 1375, it was reported in France that 10lb (4.5kg) of powder cost 12 pence a pound, while in England in 1379 saltpetre was purchased at 15 pence a pound. The cost of powder made the use of large quantities prohibitively expensive. This was at a time when the daily wage of a skilled craftsman varied from 4d to 6d a day. The 57g charge of the Loshult cannon would therefore cost perhaps half a day's wages for a labourer, while a large bombard may have consumed about 36kg of powder, a small fortune.

The first major development in the history of gunpowder in the West was the use of saltpetre 'plantations' in the last quarter of the 14th century. The ingredients were black earth (composted waste including faecal material), urine, dung, quicklime and oyster shells. The urine provided the essential ammonia, the black earth, dung and oyster shells provided a growing medium for the bacteria and the quicklime offset any acidity in the mixture. The manufacturers were remarkably precise as to the source of their raw materials and for good reason. They said the urine should be 'namely of those persons which drink either wine or strong beers'; the ammonium levels of urine

The character on the left is clearly managing the process as he is sitting in a very grand equivalent of the swivel chair. The lad doing all the work has been pounding the constituent materials in what is probably a bronze mortar, with an iron pestle which is suspended on a flexible branch. A similar system is used with a pole lathe and works very well. He is using a sieve to ensure standard-sized crumbs, a significant factor when considering the strength of the powder. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.069r)





The mass production of powder required new 'industrial' techniques. The raw materials of powder are being crushed together to form a fine powder. The sand clock on the left of the illustration would suggest that a fixed time was deemed necessary to achieve proper incorporation of the ingredients. (Courtesy of the Royal Armouries)

increases three-fold when the body metabolizes alcohol, while sodium excretion declines. The urine of a wine-drinking prelate was thought to be especially efficacious! The dung was 'specially of those horses which be fed with oats', as oats contain more potassium and less sodium than meadow or clover hay. The resultant heap should be placed in a dry, brick-lined building and turned fortnightly, with the walls and floors swept of their saltpetre, which 'will hang like snow upon them'. These conditions occurred naturally on the walls of stables and privies, although less prolifically.

The introduction of saltpetre plantations led to a rapid decline in the cost of powder. Frankfurt, which was a centre of production, saw a reduction in price from 41 florins per hundredweight (51kg) in 1381 to 16 in 1410, and to only nine or ten florins in 1439–40. In England, gunpowder cost 16d to 24d per pound in 1385–86, but only 5d by 1417, a reduction that can only be attributed to a great increase in domestic manufacture. The quantities used also increased dramatically. At Saint Sauveur le Vicomte only 91kg were used in the siege of 1375, while the Burgundians used some 7,711kg, or 7.7 tonnes, in 1471. Those who possessed the skill of making saltpetre and

good gunpowder were highly valued. Pierre de Lievenstein was employed by the Dinantais to explain the full mystery of manufacture, for a good sum, in 1465.

The consequence of the major reduction in the price led to the use of much larger weapons with larger charges. The bombard, which was to appear at this time as a serious destroyer of walls, used a prodigious amount of gunpowder and was only made possible because of the large quantities of relatively cheap powder produced in these saltpetre plantations.

Early recipes for gunpowder

	Saltpetre per cent	Sulphur per cent	Charcoal per cent
Roger Bacon (c. 1267) by weight	41.2	29.4	29.4
Roger Bacon (c. 1267) by volume	58	35	8
Albertus Magnus (c. 1275)	66.6	11.2	22.2
Marcus Graecus (c. 1350)	66.6	11.2	22.2
Rothenburg (c. 1377–80)	66.6	16.7	16.7
Montauban (c. 1400)	71.0	12.9	16.1
Burgundy (c.1413)	71.5	21.4	7.1



The ‘corning’ of gunpowder was the next great innovation. Corning involves the dampening of the dry gunpowder mixture with water, vinegar or urine and forming it into cakes, referred to in German as *Knollen*, or dumplings. This process helped limit the absorption of water – a serious problem for loose powder – but also produced a much more powerful propellant. Corned powder could be used in artillery, but only with a reduced saltpetre proportion. It seems probable that dry mixed powder continued to be used by artillery and corned powder solely by handguns.

MANUFACTURE

Bronze guns

The technology required to build small wrought iron pieces was to be found in the skilled hands of the blacksmith, whilst casting in bronze or copper alloy was a more specialized task. With the cost of bronze at 8d and iron at 2½d a pound in London in 1375 wrought-iron guns were significantly cheaper. It is therefore often assumed that cast-bronze guns were rapidly replaced by wrought-iron but this was not the case.

Although cost was an important issue, bronze was an attractive material that could produce much stronger and more forgiving pieces as it tended to show signs of strains before catastrophic failure. One of the other attractions of bronze was that in practice, ploughshares could be made into swords and vice versa. In December 1414, in preparation for the Harfleur expedition,

THE GUN ARROW OR ‘GARROS’

It is hardly surprising that the first projectiles were gun arrows; after all, arrows and bolts were the obvious exemplars and already well understood. The documentary, pictorial and surviving examples of gun arrows provide a fairly complete picture of what these remarkable projectiles were. The account of making arrows in Saint Omer in the Pas-de-Calais in 1342 and the extant examples in Burg Eltz make it clear that they were made of straight shafts which were turned at the rear, where they would be bound with leather or hemp cord to make a snug fit. The two or three fletchings were made of metal, copper, bronze or iron and would fit just in front of the binding. The rear of the garros would be fitted with a metal end cap nailed in position to avoid the shaft being broken when fired, as happened with the Royal Armouries examples. They could be fitted with large four-sided heads or special incendiary ammunition.

Jean Froissart refers to garros being used in 12 sieges between 1340 and 1387 and one battle, Rosebeke, in 1382. The

Burg Eltz in Germany was besieged by Baldwin, Archbishop of Trier, in 1331. Two gun arrows in the castle armoury have been definitively dated to the time of the siege; one may be of an earlier date and was recycled as a gun arrow. The shafts are of oak, the flights of copper and the heads of iron. The longer is 67cm in length and the shorter 54cm, with a diameter at the rear of 3cm. (© Dieter Ritzenhofen - Courtesy of Dr Karl Graf zu Eltz)

town of Laon purchased 42 cannons and 1,350 garros, with the guns costing almost exactly 2 ecus each. Money was also set aside for about 5kg for proofing the barrels, which would suggest a regular charge of about 57g, making the guns pretty much the same size as the Loshult cannon. A Burgundian inventory of 1368 included a reference to 2.5kgs of powder for 40 bolts, again at 57g per bolt. Gun arrows continued to be found in arsenals until the last quarter of the 14th century. Jean Froissart when describing the siege of Odruiik near Calais in 1377 records a remarkable success.

‘Then the duke of Burgundy set up his cannons and fired maybe five or six quarrels in order to provoke a surrender. These quarrels were such that, because of the power of the discharge, they penetrated the walls. When those in the castle saw the strength of the artillery which the duke had, they doubted themselves more than ever before ... and the duke fired from his cannons two hundred quarrels in number, which penetrated the walls ... [the garrison] surrendered the fortress, to save their lives.’

William Woodward and Gerard Sprong were commissioned to cast guns from the pots and pans in King Henry V's own kitchens. The ability of copper and bronze to be melted down and cast again and again explains their attractiveness as a material, and also why so few early bronze guns remain.

From the 14th century onwards, bronze cannons were manufactured in a few key areas – southern Germany, Flanders and the great northern Italian city-states. These had access to material, the skills to work them and the wealth to purchase them. The skills of the bellfounder could be applied to the casting of cannons, but with one significant alteration – a reduction in the percentage of tin. Bells contained 25 per cent tin, which made them brittle, an unsatisfactory characteristic in a cannon operating under high pressures. The reduction of the proportion of tin to about 10 per cent made the metal much tougher than bell bronze, while it was between five and ten times harder than pure copper.

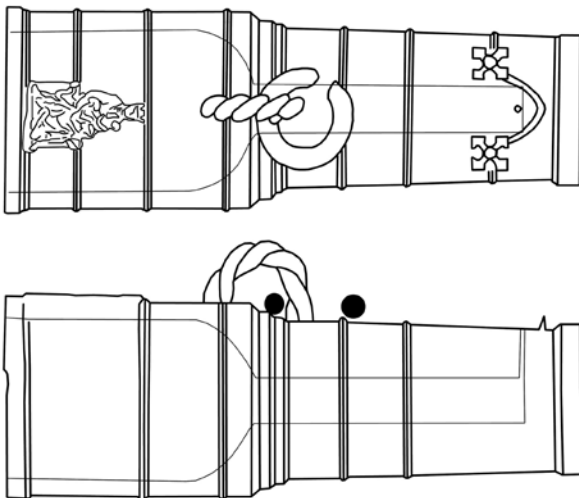
Bronze guns were cast throughout this period as is proved by documentary material, contemporary illustrations and surviving examples, although those are rare indeed, probably for the reason suggested above. In 1354, King John of France ordered an embargo on all copper exports from France until provision for artillery manufacture was assured. Richard II of England purchased both iron and bronze guns, although they were small pieces and with the bronze at a significantly higher cost. In 1428, Henry VI purchased 64 small artillery pieces called fowlers from two citizens and metal founders of London, Thomas Coston and Robert Warner. The detailed description of two of the pieces is especially useful:

II canonis of bronze called ffoulers, firing stones weighing 2lbs. Each of which are 1½ feet in length, which in total weigh 168lbs, price per lb 6d. Purchased of Robert Warner, citizen and founder of London ... the sum of £4 4s.

This gun would be considered the equivalent of what would later be described as a falcon. Its very short length would suggest a great thickness of metal and consequent safety for the gunners.

The majority of cast guns were probably small like Warner's fowlers, but

Although the exterior rings might suggest this gun was of cast-iron construction, it was in fact cast from bronze, as is evident from looking at the mouth of the gun. Cast for the Teutonic knights, it could well be an early 15th-century gun and certainly of no later date than 1454, when the castle of Kurzętnik in Poland was demolished. Internal evidence suggests it was probably cast muzzle upwards using the lost wax process. It weighs some 42kg and fired a stone ball of about 3kg. It was probably fitted to a simple two-wheeled carriage. To safely contain the pressure generated by the expansion of the powder, the breech was made of thicker material than the barrel. The purpose of the barrel was to direct the projectile. (Image courtesy of Grzegorz Żabiński)





The bombard *Die Katerie* was cast in 1487 by George Endorfer, a famous gunfounder from Innsbruck. It weighs 4,597kg and has a bore of 38cm. It is fitted with dolphins and four rectangular projections that could have been used when lifting the gun onto its mounting or for holding it there. (Paris - Musée de l'Armée, Dist. RMN-Grand Palais / Emilie Cambier)

larger guns were also manufactured. In 1408, a gun of 180cwt in weight was cast at Marienburg under the direction of Johann von Christburg, for the Teutonic Knights in their war with the Poles. In 1433, John, Duke of Bedford, gave to Peter, Count of Saint-Pol, a large bombard for the siege of Saint-Valéry-sur-Somme. It weighed 1,770kg and was cast with the arms of England and the following words, 'Henry IV made me out of the metal of 49 guns' – further evidence of why bronze, despite its expense, was so attractive and how small most cannons were. The process of casting such large weapons would have required the creation of a mould around a positive model of the gun. The bore would be cast by placing a core of material in the hollow mould, which would be removed after casting.

Even larger bronze bombards were cast for the Sultan Mehmet in his final assault on Constantinople in 1453. One pair of guns each had a barrel 0.9m in diameter, pulled into position by 70 oxen and 1,000 men. They fired projectiles weighing 397kg up to 1¼ miles. Perhaps unsurprisingly, one gun burst on firing, attributed to sabotage.

Two guns that were cast right at the end of this period are magnificent survivals from the epic siege of Rhodes when the Hospitallers were finally driven from their island stronghold.

One weighs 3,325kg, with a bore diameter of 58cm, was a gift from Pierre d'Aubusson, the Grand Master of the Order, and was fitted with trunnions; the other was the bombard *Die Katerie*. Both guns were captured in the siege and kept, no doubt as trophy pieces, but were eventually presented to Napoleon III in 1862, a history that explains their remarkable survival.

Wrought-iron guns

To understand the development of wrought-iron artillery it is first necessary to understand something of the material from which they were made. Iron in the Middle Ages was produced in a furnace known as a bloomery. The product was a spongy bloom of iron and slag which was further refined through hammering. The iron was wrought or worked to produce a malleable product and was therefore known as wrought iron.

The quantity of iron produced in a bloomery was unsurprisingly small, reflecting the limitations of the draft produced by hand-powered bellows and the strength of the smiths in manipulating the blooms. In the early medieval period, blooms of up to 15kg seem to have been the norm and quite adequate to produce the *handgonnes* used in such quantity by the Hussites of Bohemia.

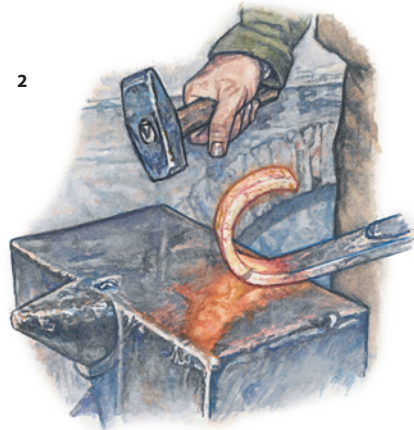
MAKING A WROUGHT-IRON GUN

The assumption that the iron produced in the medieval period was somehow 'inferior' was belied by trials conducted in 1861 on two guns dated to the reign of Henry VI (1422–61). It was found that they had a tensile strength of 55,528lb per square inch (383 MPa), as good as the best wrought iron produced 400 years later and even today. A Burgundian inventory of 1449 records 22 veuglaires with 64 chambers 'for those veuglaires', suggesting a degree of inter-operability, which was the product of an impressive degree of precision. Evidence from parts of seven bombards used at the siege of Baza in 1489 suggests they were nearly identical and able to use the same calibre ammunition. Some of the barrels were eventually even used as pillars for a butcher's shop. Craft manufacture, as demonstrated in this plate, does not mean that large-scale production to a high standard was not possible. None of the tasks required to make a wrought-iron gun would have been beyond the competence of a skilled blacksmith. Clearly the largest guns were produced in a workshop under the control of an individual skilled in their manufacture. High velocities have been achieved with wrought-iron guns, but they could never match the performance and integrity of cast pieces when used with heavy charges and iron shot. The comparatively low charge that was employed in wrought-iron guns, essential to ensure the integrity of the chamber and barrel, was best suited to propelling a relatively light stone projectile, but still with more than enough velocity to do damage to their targets. These guns were masterpieces in every sense of the word.

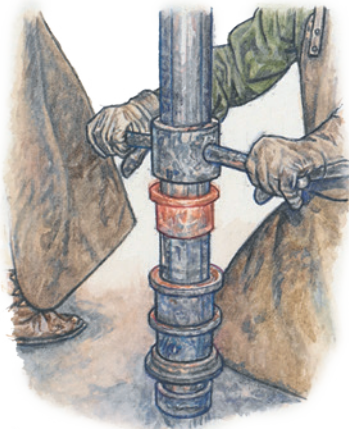
1



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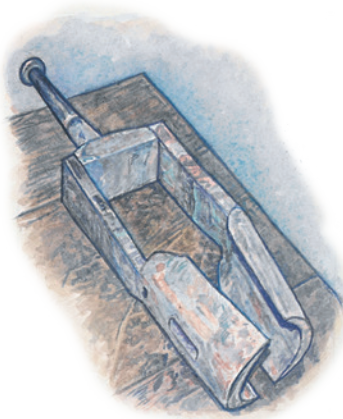
KEY

1. The barrel is made from several staves or strips butted up against each other, not welded.
2. Forging a strengthening ring, the quality of the welding was crucial.
3. Hammering the strengthening ring along the barrel, hot and hard work for Jens and Søren.
4. Hammering one of the rings and hoops into place, note the trunnions have already been fitted.
5. The breech – into which the separate chamber is fitted, held with a wedge.
6. The breech being heated in the forge, preparing to have the barrel attached.
7. Fitting the swivel onto the gun.
8. The finished gun ready for test firing. The stone shot would first be placed in the barrel. The chamber is part-filled with powder and a wooden tompion hammered in. Wedged into place, the chamber is primed with powder down the touch hole and ignited with match cord.

5



6



7



8





The process of making the hoops and bands would not greatly challenge the skills of an experienced blacksmith. Speed and ease of construction were obviously attractive features of wrought-iron guns. It took only six weeks for Bernard de Montferrat, *maître de canons*, to forge a wrought-iron gun in 1375, with the assistance of three forges, five masters and nine apprentices. (Courtesy of the Middelaldercentret)

The individual staves from which the barrel is made are well illustrated here. The lips of the staves were turned up and held the first ring in position. The first hoop was often fitted with a rudimentary foresight, which could be fitted cold with subsequent hoops and staves fitted hot. (Author's collection)

In Catalonia an improvement on the traditional bloomery, the Catalan forge, enabled much larger blooms of around 300kg to be produced. By the 14th century, the European iron industry was producing large quantities of high-quality and relatively cheap iron.

Wrought iron has a very low carbon content of less than 0.1 per cent. Fibrous slag inclusions, which make up about 2 per cent of the mass, give it a 'grain', assist the process of heat welding and resist corrosion. Wrought iron can be heated again and again and reworked. The material is ductile with a strong tensile strength, making it an ideal material for the manufacture of artillery as it is easily worked and strong. If the metal is brought into the range 1,150–1,350 degrees centigrade, then by hammering it a smith can produce almost perfect welds as the slag inclusion melts and covers the join, which stops the oxidation process which would make the weld fail.

Small wrought-iron guns could be made from a single sheet of wrought iron, wrapped round a mandrel, heat-welded and then closed at one end. Artillery of all sizes was made in a process like that of the manufacture of a wooden barrel. Strips or staves of iron could be placed edge-to-edge around a wooden mandrel, held together by a series of hoops and bands that would be placed around the staves when hot and through cooling would contract, forcing the staves to fit together closely.

The research of Robert D. Smith has demonstrated that there is no evidence that the staves were ever welded together, as often suggested. X-radiography of wrought-iron guns show up the clear lines of the individual

staves, which would hardly be visible if welded. The hoops were made by welding a length of iron over a mandrel. The hoop was lap-joined, that is both ends were tapered and then overlapped. The diameter of the hoop could be reduced by hammering its side and increased by hammering its outer edge. Although it is suggested that molten lead could be poured into any joins, no evidence has been discovered to support this.

The barrel could be sealed at one end with a block shrunk and welded in place, or could be supplied with a removable powder chamber. The advantage of the latter is obvious in terms of speed





Some 33 lead projectiles were discovered on the site of Bosworth battlefield. They vary from 30–94mm in diameter and came from at least ten different pieces of artillery. Many contain iron cubes, pebbles or flint fragments, which may have been used to save expensive lead. They reveal the damage that would be expected when hitting the ground, but some clearly show a flattened circular impact point from the tompon, or wooden plug, fitted at the mouth of the breech. (Image courtesy of Leicestershire County Council)

of loading. The separate chamber could be made like the barrel of hoop-and-stave construction or by hammer-welding pieces of iron together. The first reference to a separate chamber is in the reign of Edward III in 1338, where three cannons were provided with five, one assumes interchangeable, chambers. For the largest pieces of wrought-iron artillery, commonly referred to as bombards, it was impossible to have a separate chamber.

Wrought iron has of course a propensity to rust, especially in a marine environment. Bronze develops a protective patina which preserves it almost indefinitely. Burgundian iron guns seem to have had layers of varnish or paint: some surviving pieces have evidence of red paint. Some rare guns have had a layer of molten tin and even bronze applied to their exterior surface.

The wrought-iron gun was a remarkable contribution to the history of artillery. Economical in both manufacture and operation, and taking full advantage of the qualities of the material from which it was made, it produced a very successful and long-lasting equipment. Wrought-iron guns were still an important part of the English navy's supply of ordnance in the middle of the 16th century, and would continue to be produced and used on

AMMUNITION

The ammunition for smaller pieces tended to be made of lead or of cast-iron cubes, flints or stones coated in lead. Stone balls seem to have been used in larger guns. Stone was the ideal material for shot fired from medieval cannons. The density of iron is three times that of granite and marble. The pressure required to move a large diameter projectile made of stone is far less than that for iron, so the relatively thin-walled and comparatively weak construction of an iron hoop-and-stave-built gun was far more likely to survive such pressure if stone rather than iron projectiles were used. The lower sectional density of stone meant that for a powder charge a third of the shot weight, it could achieve almost the same velocity as a gun firing an iron projectile with a powder charge two-thirds

of the shot weight. The disadvantages were an inevitable variation in diameter and weight of the ball, the time and cost of manufacture of the stone ball and the occasional shattering of stone projectiles, either in flight or when hitting a harder surface.

In the medieval High Turret in Olsztyn, Poland, baked clay projectiles were discovered together with stone shot. Well-fired and carefully produced, they were about a third lighter than equivalent stone projectiles. They would have been of little use against a hard target but very economical, as cost of manufacture would have been much lower, less powder would have been used in firing and probably there would have been less wear on the barrel. Also in Poland, tubular iron projectiles have been found, as well as cannon balls made from glass.

a smaller scale for at least a century after that. It was never the crude and dangerous weapon often depicted.

Cast-iron guns

Cast iron is a material normally associated with cannons in the mid-16th century rather than the Middle Ages. The first date given for the manufacture of cast-iron ordnance in Europe was 1377 in Erfurt in central Germany. There is evidence for the existence of cast-iron guns in Burgundian hands in 1414–15, in 1432 Philip the Good of Burgundy ordered them for use in the ducal artillery, while in 1445 30 iron guns were cast in Siegen in Germany. The Italian artist and engineer Taccola, when considering material suitable for a bombard in 1433, declared that ‘the bombard is the father of all instruments and machines and of all shooting engines. These bombards of iron are good made of [wrought] iron, but it is better to make them of cast iron [*de ferro colato*] since this is of tough nature and makes harder tubes.’

If many wrought-iron guns survive from the medieval period, there are very few of cast iron. In Italy, four small cast-iron bombards owned by the Counts da Schio survive. Dating from 1450–90, they display the features normally associated with such weapons: a short sub-calibre powder chamber and a wide short barrel. In England, the only example of a cast-iron gun is the curious and confusing Bodiam mortar, which is a cast/wrought-iron hybrid. Sometimes referred to as the Crecy gun, it certainly does not date from then but may be from the late 15th or even early 16th century. Cast-iron guns were certainly to be found in the late Middle Ages, but were few and far between compared to their wrought iron and bronze brethren, being somewhat experimental in nature.

Bombards

The bombard has been condemned as little more than a status symbol and lauded as the means by which the nobility of Christendom was brought to heel by a revived monarchy. It was in practice a thoroughly practical and, for its time, efficient weapon of war. Its reign as ‘queen’ of artillery was short,

B

NORHAM CASTLE SIEGE, 1497

Mons Meg, or rather *Mons* as it was called at the time – the appellation *Meg* being added later – is seen here being placed in position at the siege of Norham in 1497. Before it could depart from Edinburgh, its ‘cradill’, or carriage, had to be made anew, with iron and timber bought specially. The cradill took seven wheel/cartwrights two-and-a-half days to complete at 23s 4d (in Scots coin). The wheels and axletrees were greased with best Orkney butter to better smooth its passage. Its departure would have been a spectacle; *Mons* was covered with a newly painted cloth and 14s was paid ‘to the Minstrals that playit before *Mons* doune the gate’. Going to war was an act of state, and therefore had to be accompanied by suitable ceremony. Accompanying *Mons* itself would have been a *gyn*, *engyn* or crane, which was essential for loading and unloading the gun, its ammunition – both powder and shot – as well as the timber for the mounting and protective mantlet. The handling of heavy loads was well understood, using a block and tackle, sometimes fitted with copper sheaves for rigorous service. *Mons* was probably emplaced on the Scottish side of the River Tweed some 500 yards from the castle and at almost the same elevation. Its maximum range was considerably more, but at this distance it would be a fairly ‘flat’ shot. A team from QinetiQ at Fort Halstead have carried out a detailed analysis of *Mons Meg*, accurately predicting the precise part that failed in 1680. They calculated that with period powder, a velocity of a little over 300m/sec would have been achieved, not enough to smash through a contemporary 1m-thick wall with its 150kg (330lb) ball. During the fortnight-long siege, the gun apparently did considerable damage to the walls, which would suggest at least a reasonable rate of fire and accuracy.



This archetypal bombard was the product of the workshop of Jean Cambier on behalf of the Duke of Burgundy. '*Dulle Griet*', or *Mad Margaret*, was the bigger sister of *Mons Meg* and the Basel Bombard. The barrel is 7/10ths of the total length, and the internal length of the barrel is five to five-and-a-half times the bore. It also shares the same distinctive stepped shape as the other guns. (Karelj / Wikimedia Commons / Public Domain)



The Dardanelles Gun was cast in 1464, some 11 years after the capture of Constantinople using similar weapons. It had been thought that the breech was unscrewed for loading purposes, but this seems unlikely. It was clearly easier to cast and transport such a weapon, weighing in total almost 17 tons, in two parts. This type of gun was used against an English squadron attempting to breach the Dardanelles in 1807: one shot from the battery killed and wounded 60 men and left a gaping 60cm-wide hole in the hull of one unfortunate ship. (Gaius Cornelius / Wikimedia Commons / Public Domain)

but not inglorious; it appeared in the third quarter of the 14th century and was to remain an archaic feature of European arsenals until the mid-16th century, a testimony to its power and practicality.

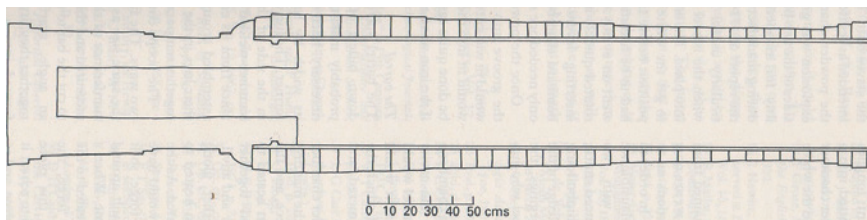
The most famous and largest of its type in Britain is, of course, *Mons Meg*, still to be found in Edinburgh Castle. Built in 1449 in Mons for Philip the Good, Duke of Burgundy, it cost quite literally a small fortune: £1,536 and 2 shillings. It was made by Jean Cambier, the gunfounder to the Duchy of Burgundy. It was sent to James II of Scotland in 1457 as a gift, where it was known simply as *Mons*. It appears to modern eyes to be a monstrous novelty: how could it be loaded and aimed, in fact how could such a load be transported around Scotland? Yet it had trundled out of Edinburgh to take part in the sieges of Dumbarton Castle (1489) and Norham (1497), and possibly Roxburgh (1460). Its sad end only came in 1680 when its barrel burst, 231 years after its conception.

Most bombards were built of wrought iron using the conventional stave-built construction, but on a massive scale, while others were manufactured from cast bronze, which was safer but also more expensive and heavier. The massive weight of bronze bombards encouraged their manufacture with a

separate powder chamber to enable easier manufacture and transport. The two parts could be screwed together on-site using the windlass sockets fitted usually at the breech and both ends of the muzzle.

The Ottomans are perhaps the power most associated with cast-bronze bombards. They are referred to in the siege of Corinth in 1446 and above all at the successful siege of Constantinople in 1453, where they had over a dozen monster cannons to breach the 5m-thick and 12m-high defences of the city. The siege





Mons Meg was similar in design to all large wrought-iron guns. A groove was made at the mouth of the breech, matched by a ring welded on to the staves of the barrel. The breech chamber was made strong enough to resist the combustion of the powder; the weak point was where the breech and barrel joined and where the barrel was breached in 1680. (Courtesy of the Royal Armouries)

guns of Sultan Mahomet II were cast in Adrianople from scrapped cannons, under the supervision of the renegade Hungarian Urban. This use of foreign experts was not unknown. A German gunfounder and master gunner served at the siege of Rhodes against the Knights Hospitallers, and another Christian later captured by the Knights was hanged by them for his treachery.

The complex and expensive process of manufacturing an iron bombard began with the construction of the breech. Slot holes were put into the breech rings to enable the breech and then the gun to be more easily manipulated during the manufacturing process, as well as providing in some cases attachment points for the crane slings. A groove was made at the mouth of the breech, matched by a ring welded on to the staves of the barrel.

The ratio of powder to projectile weight was limited by the weakness of the iron structure and the weight of the projectile. If breech pressures were to remain within safe limits, a ratio of seven or eight pounds of projectile for each pound of powder seems to have been common for the largest examples (300–400lb, or 136–181kg, shot), whilst the smaller had a higher ratio of powder to shot. Thus, although projectile weight could be made heavier, its velocity could not be easily or safely increased.

The rate of fire of such monsters is difficult to establish, as contemporary evidence is not extensive and only one modern reconstruction has been built. The process of preparing such a large weapon must have been time-consuming. The volume of powder required was massive, while the difficulty of placing it accurately in the sub-calibre chamber was great. The projectiles must have been the cause of great labour, both in their manufacture and physical movement. To minimize the loss of power caused by the irregular barrel and ball, there must have been considerable effort expended in closing the breech with a tompion, centring the projectile with wedges and creating a seal around the projectile, with earth or clay.

The discharge of the weapon would have produced considerable fouling of the chamber, which would have to be cleaned, and the recoil of the weapon must have caused damage to the bedding, with the gun needing to be relaid. The experience of the crews, the number of labourers available, the availability of powder and shot and the urgency of the siege would all have affected the rate of fire. At a siege of Metz in 1437, one gunner

The Boxted bombard of about 1450 is 2.34m long, weighs approximately 1.5 tons and would have shot a stone ball weighing about 60kg. Such a gun would produce the same deadly effect as the trebuchet, which was much heavier and larger to transport and erect. It would require little maintenance and made for an impressive display item in time of peace. This gun was still in use at the end of the 18th century, firing an iron projectile a mile away at the behest of fairground crowds that would club together to pay for the powder! (Courtesy of the Royal Armouries)





This magnificent reconstruction of a full-scale trebuchet at the Danish Middle Ages Centre is almost 18.3m tall and weighs approximately 20 tons. It takes some 15 minutes to load with a crew of seven or eight. Although impressive in operation and able to shoot a variety of projectiles, its sheer scale made it a difficult task to move and it would require regular maintenance. (Author's collection)

achieved the apparently remarkable rate of fire of three rounds in a single day from his gun. So extraordinary was this perceived to be that the only explanation that could be found was that he had employed the assistance of the Devil, and he was sent on a penitential pilgrimage to Rome. In 1453, the great bombards were fired at the city walls of Constantinople seven times a day, and in 1513 it was recorded that an English bombard throwing an iron ball weighing 118kg 'may be shot V tymes a day'. This pales in comparison to the Burgundian bombards of 1488, which were expected to shoot an impressive 12 times a day. Not all bombards were worked so hard. *Faule*

Mette was shot only a dozen times in its lifetime, five times in war, thrice in two days in 1492, a performance (or lack of) which might explain its appellation of *Faule* ('Lazy'). The provision of a little over 100 projectiles for the largest bombards in a Milanese siege train recorded in 1470–72, would suggest that a slow rate of fire was expected – either that or miraculously short sieges.

The emplacement of such large guns was itself a considerable challenge. They could be supported on the ground by two large baulks of timber or placed on an oak or elm bed. Elevation was achieved by simply raising the muzzle on trestles, or if the bombard was placed upon a bed, by raising that on an earthen ramp. The recoil of the large mass of iron was dealt with by the use of a lead oreiller (pillow), solid timber reinforcements, earthen banks



This scene taken from Diebold Schilling's *Spiezer Chronik* of 1484–85 illustrates several aspects of a late medieval siege. Heavy timbers are being used to accept the recoil from the bombard, protected by a swinging shutter. Infantry carry out harassing fire from behind a well-constructed *mantlet*, while a brave soul advances behind a pavise. It also illustrates the dangers of peering out of windows when a siege is in progress. (Burgerbibliothek Bern, Mss.h.I.1, p. 132)

or in the case of the Dardanelles guns, a reinforced wall against which the massive beams of the bed rested.

For the sake of effect, the gun had to be sited as close to the enemy as possible. Harassing fire from archers and crossbowmen would reach to well over 274m. In the light of this, it was essential that the weapon be provided with a protective screen and a shutter that could be opened by the crew when the weapon was to be fired. The range achieved by *Mons Meg*, from Edinburgh Castle to Wardie Muir, from where soldiers were paid to collect balls shot in 1558, was a little over 3km, achievable with an elevation of 25 degrees and a muzzle velocity of a little over 300m/s. At the siege of Vyšehrad in Bohemia in 1420 a large bombard fired a shot that flew some 1600m. An analysis of sieges in Poland and Bohemia in the early 15th century would suggest that 500m was a more usual range if accuracy of any sort was to be expected.

Bombards continued in armouries throughout the 15th century and into the 16th century, whilst Ottoman guns served for centuries afterwards. Sheer destructive power made the bombard attractive to those who could afford it. Its longevity and durability made it desirable and its role as a status symbol made it especially sought after.

Comparative data on surviving bombards					
Name	Date	Length	Bore	Weight	Projectile Weight
Les Michallettes .a	c. 1400–1420	3.33m	41cm	3.25t	81kg
Les Michallettes .b	c. 1400–1420	3.64m	51cm	5.3t	158kg
Paris Bombard	c. 1450	2.02m	48cm		150kg
Boxted Bombard	c.1450	2.34m	34cm		50kg
Basel Bombard	c. 1420–1455	2.72m	34cm		50kg
Dulle Griet	c. 1450	5.01m	64cm	16.4t	300kg
Mons Meg	1449	4.04m	48cm	6.04t	150kg
Pumhart von Steyr	Early 15th century	2.59m	76–88cm	8t	690kg

Proofing

It was obviously essential for the safety of the crew, the reputation of the maker and the prestige of the owner for cannons to be proofed. There are plenty of examples of guns blowing up. In 1408, one large bronze gun, named the *Messenger*, burst at the siege of Aberystwyth, and a second even larger gun, the bravely named *King's Daughter*, failed at Harlech. During the trials of the *Mary Rose* port piece in 1999, there was a catastrophic failure which replicated a common accident and highlights the weaknesses of the wrought-iron gun if over-charged.

Plug at rear of breech chamber set back. The inner staves were pulled back. The elm forelock was broken; it and the iron wedge were pushed up and ejected. The breech chamber was partially displaced from the bed. The staves at mouth of the chamber were also damaged, with one piece of stave being broken off and thrown some distance.

King James II of Scotland was killed in 1460 in an almost identical accident at the siege of Roxburgh, when a wedge flew from the breech of



C

LOGISTICS

It is sometimes assumed that as long as the archer had his bow and arrows and the knight his horse and lance, then little more was needed to provide for a medieval army. This is not true, especially of any campaign that involved the prospect of a siege, as most did. This plate demonstrates some of the equipment needed to transport a single bombard. In the case of the heavy bombard *Bourgoigne*, two very large carts were needed for the iron barrel (1) and bronze breech (2), two ordinary carts carried 24 stone shot (3), one cart carried the 'engine' to unload the gun (4) and one further cart contained a large barrel filled with ropes and three barrels of gunpowder (5). In total, 100 horses were needed to move this single piece. Other carts would have been needed to carry the spades, mattocks and other pioneer gear. A similar Burgundian bombard required a further four carts to carry a protective wooden mantlet, and another cart to carry the *afust*, or substantial wooden mounting, in total requiring 44 more beasts. Horses rather than oxen seem to have been used to draw the carts, more because of their speed than pulling power, which was, according to a 14th-century Florentine source, only two-thirds that of an ox. On the other hand, a horse-drawn cart would proceed at twice the pace of an equivalent ox cart. The *Bourgoigne* was part of a larger convoy that travelled 570km (354 miles) to the siege of Calais at 11.5km a day (7 miles). Two other convoys moved at an average speed of 12km and 20km per day (7.5 and 12.4 miles). While slower than unaccompanied infantry or cavalry, the movement of artillery need not have been a serious source of delay if well managed.



This small 'terrace' gun made from cast bronze has suffered a catastrophic failure. The barrel is 1.07m in length, with a 3cm bore. The breech wall is little more than 2.5cm thick. An uneven thickness of metal or an oval cross-section were also potential causes of such incidents. (Image courtesy of Dr Piotr Strzyz)



the *Lion* and shattered his thigh, which was, according to a contemporary record, 'dung in twa'.

To obviate the danger to the crew or passing monarch, it was apparent that some form of proofing was necessary. As previously referred to, the town of Laon took care to proof its newly purchased cannon. In 1422, a bombard cast by Master Bertold von Melvrode called *Faule Mette* cracked when test-fired. The cannons intended for the English expedition against France in 1428 seem to have been proofed before departure, and one bombard named the *Bristol* burst.

Not too much should be made of the danger. In the siege of Harfleur, where there are detailed statistics, some 7,466 gunstones were fired: 866 by the bombards, 3,600 by the large fowlers and 3,000 by the small fowlers. It is a testimony to the reliability of these weapons that only one large fowler burst, although others may have been damaged. The oft-repeated statement that early cannons were as dangerous to their crews as to their enemies is palpable nonsense.

A dramatic photograph of a cannon bursting. Fragments of iron can be seen flying and the crew fleeing. The consistency of metal, the variable quality of the powder and poor training could all produce such a calamity. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.163r)



The spread of gun-making

Kennard's list of over 100 gunfounders in the 15th century shows the industry developing in northern Italy, southern Germany and the Low Countries. If the Low Countries was at the heart of the new technology, Germany was quick to follow. Strasbourg became a producer of guns from the mid-14th century, although the industry took off in the next century. Big gun-making industries grew in southern Germany in Augsburg, Nurnberg and Thuringia in the 15th century. The iron-making tradition of Lombardy made it ideal for the development of wrought-iron guns, while access to the Venetian copper markets would have encouraged casting of cannons as well.

In Bruges, during the 14th century the numbers of metal founders grew from 20 to 66, and smiths from 21 to 75. In France, Rouen became a centre for ordnance manufacture for the English, Henry V having established a new foundry there in 1419, whilst Orleans also set up a gun foundry in 1411 to help counter English incursions.

USING CANNONS

Gunners

If the demand for guns and gun-makers grew quickly from the 1340s onward, the demand for Master Gunners grew with it. The *maitre d'artillerie*, or *buchsenmeister*, would become a key figure in castle and siege. There is much written and pictorial evidence for the transmission of this somewhat arcane knowledge at the end of the 14th century, when Firework-books came into fashion, and there are many examples from the 15th century.

The independent Duchy of Brittany had good cause to arm itself well, caught between two powerful kingdoms vying for control of France, and provides an excellent example of how the demand for gunners grew to captain the hundreds of weapons that were manufactured. The Duke appointed *cannoniers de duc*, while cities independently appointed *maitres d'artillerie*. Some 217 named individuals are known to be involved in the manufacture or management of ordnance from 1418, but the majority from the 1440s. Just as there had been guilds of archers and crossbowmen, now the cities and towns established guilds of gunners, culveriniers and hackbutters. Some individuals are named and their previous occupation recorded: there was Breto Larchier, a bombardier but formerly a nail-maker; Didier Morel had previously been a carpenter. In English service it appears that former archers were commonly employed as artillerists, although master gunners were usually hired from Germany or the Low Countries, a practice that remained common well into the 16th century.

Loading powder

Gunpowder burns rapidly as a fine spray of molten salts move through the powder mass. To assist this process there has to be a quantity of empty space between the grains; in grained powder, the free space between the granules amounts to 25 per cent. Powder for a rocket is packed tightly, which makes it burn slowly from one end to the other, producing propellant gas. Packing powder too tightly was warned against for just this reason. In the *Arte of Shooting in Great Ordnance* (1587), Bourne asserted that:

The powder rammed too hard and the wad also, it will be long before the piece goes off... The powder too loose ... will make the shotte to come off the mark.

In contemporary records relating to artillery stores, there are often references to tampions or tompions, wooden discs or tubes, turned from elm and poplar, that sealed the breech chamber of early guns. In 1418, Henry V ordered for his siege train 7,000 tompions, for the same number of gunstones. Only 60 per cent of the chamber would be filled with powder, the tompion taking up a further 20 per cent and the remaining space left empty. Once ignited, the powder would fill the whole chamber and

The mysteries of medieval crafts, whether goldsmith, mason or shipwright, were transmitted without the benefit of detailed manuals, and gunnery would have been little different. Here a novice gunner is being instructed in the art of priming the piece using a funnel. A practice I have never followed and makes me wonder whether I ought to. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.021v)



burn faster and more completely; when enough pressure was achieved, the tampion would be expelled like a cork from a champagne bottle.

Firing trials of the <i>Mary Rose</i> port piece						
Shot	Windage	Shot type/ weight	Charge weight	Target type	Distance	Muzzle velocity
1	25mm	Limestone 11lb 15oz	2lb	Earth bank	c. 20m	141m/s
2	25mm	Limestone 12lb	3lb	Stone wall	17.2m	160m/s
3	25mm	Kentish ragstone 13lb	3lb 3oz	Oak target	17.2m	240m/s
4	13mm	Limestone 13lb 11oz	3lb 8oz	Oak target	17.2m	298m/s
5	25mm	Lantern shot 25lb 2oz	3lb	Oak target	15.7m	n/a
6	7mm	Limestone 15lb	3lb 12oz	Reinforced bunker	131m	338m/s

In 1999, the Royal Armouries carried out some impressive trials of a large wrought-iron gun, a replica of a type found in the *Mary Rose*. Although the *Mary Rose* sank in 1545, the gun itself (known as a ‘port piece’) was identical in construction and size to weapons that would have been used 75 years before.

The results show that even with a small charge of powder, high velocities could be reached (shot 1), also that similar charges and shot could reach quite different velocities (shots 2 and 3). A 50 per cent variation in muzzle velocity for an increase in powder loading of 8.5 per cent would suggest that consistency was difficult to achieve. The impact on the ‘ship’ target was impressive. Shot 4, for example, substantially damaged ‘all three layers of the structure, the outer planking, frames and inner stringer’. Undoubtedly, at short range with stone shot the hull of a major warship would have been very vulnerable.

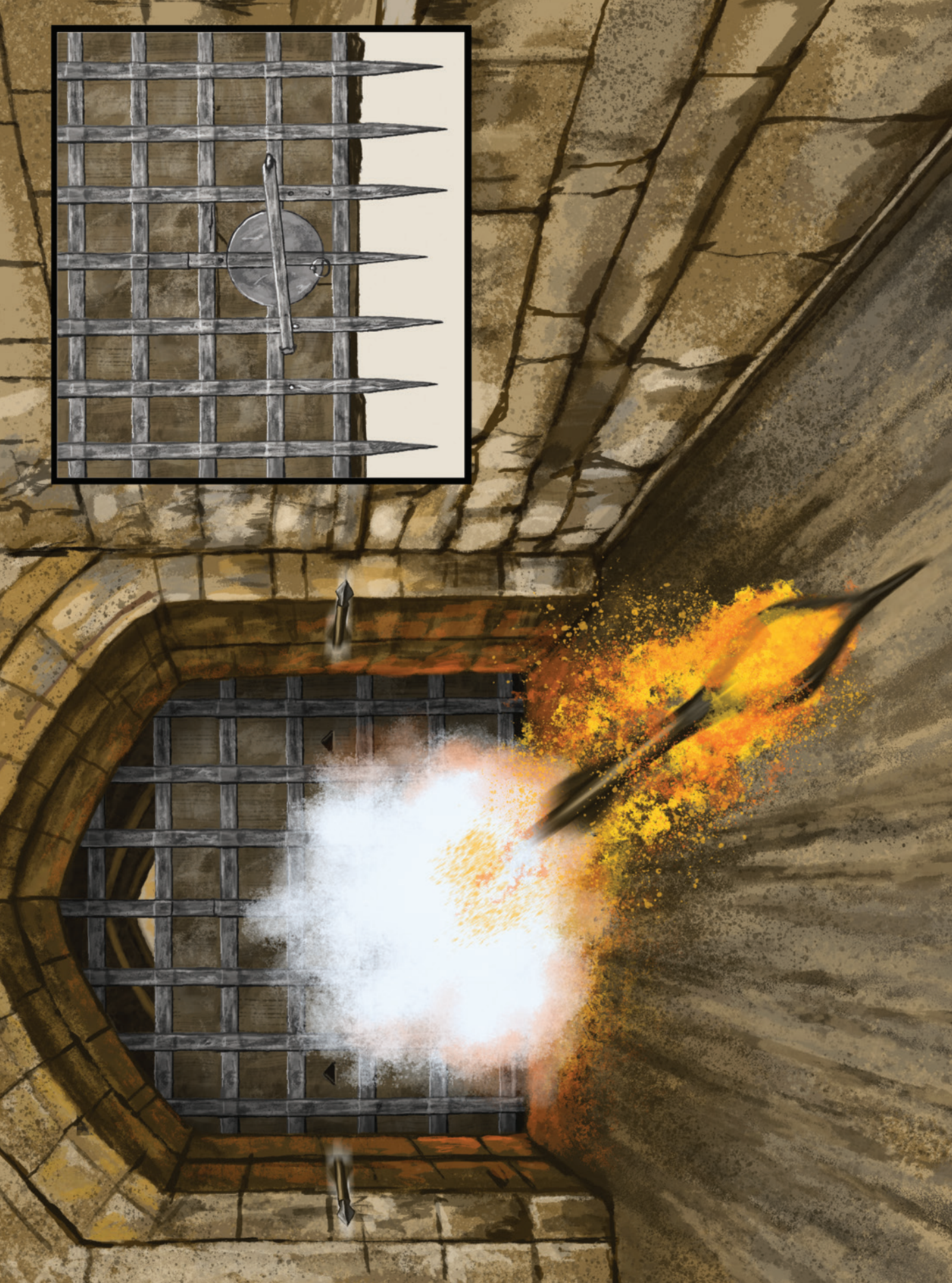
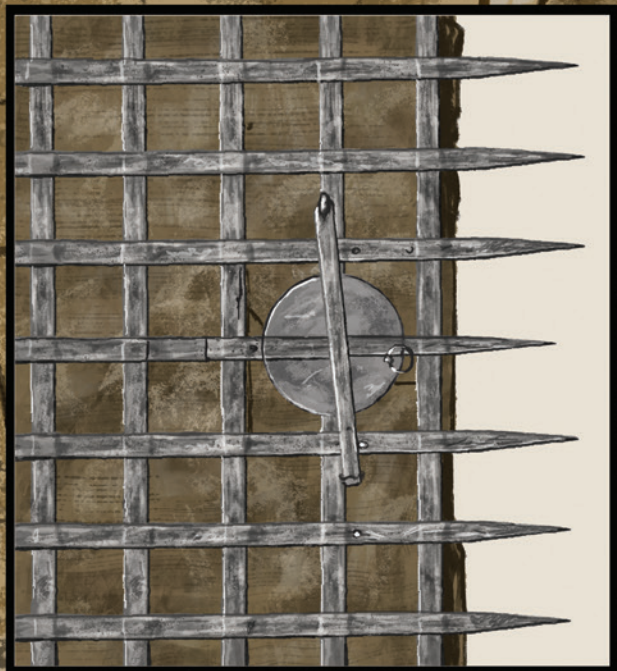
Mounts, carts, carriages and emplacements

Early guns seem to have fitted on or in ‘beds’ of oak or elm, to which they could be fixed by iron fastenings, ropework or both. Recesses would be cut into the

D

ATTACK ON THE TOWER, 1381

Although the Tower of London was surrendered without a fight to the peasants in the revolt of 1381, its defences were considerable. The Byward Tower, the principal entrance to the Tower, still has in place its original portcullis, which would have been a formidable obstacle to attackers. It is overlaid with substantial oak boards on the outside, which reach to the height of a man. In the centre is a circular gun port that could be secured with iron bars. It is fitted at precisely the height of the gun mount I use for my reconstruction of the Loshult cannon. The recent trials by the Middelaldercentret have demonstrated the effectiveness of this type of gun. The effect of the different projectiles was assessed against a range of targets. Firstly, a 1.5mm steel plate was used, equivalent to the plate armour available in the late 14th century. A padded arming doublet also provided an authentic target, as did a reproduction of the leather jerkin reinforced with steel plates, a copy of one found in the grave pit from the battle of Visby 1369. The wooden quarrels and the lead balls penetrated all the targets with ease. The iron ‘dice’ proved lethal to the doublet and severely damaged but failed to penetrate the plate and Visby armour. When properly loaded, they would have proved fatal to any unarmoured men 20m away and up to one or two metres to the left and right of the line of fire. The sound of the explosion and the sight of a *garros* travelling at about 100m/sec would have been enough to terrify even the bravest attacker.



The bronze bombard is being moved on its own wagon, or *cradill*, by a large number of horses, while the light field piece fitted with an elevating arc is drawn by a single animal ridden side-saddle by the carter. A large siege train would absorb a vast amount of effort and equipment, and added greatly to the cost of war. (Burgerbibliothek Bern, Mss.h.h.1.3, p. 148)



bed to match the hoops on the barrel; these recesses were important, as when the gun was fired the barrel would be forced forward by the force of the explosion, just as the breech chamber was forced back by the recoil. The chamber was held in place with a wooden forelock that was designed to absorb the recoil over its whole surface, and this was further held in place with a wedge.

Small wheels could be added to aid mobility or more likely to help aim. By the middle of the 15th century, the wooden bed could be hinged at the front and a wooden trail fitted to an axle below, creating a mobile field gun. The elevation of the gun could be achieved with a simple wooden or iron arc.

The invention of the trunnion, a pivot fitted to or intrinsic to a barrel, enabling the gun to be elevated has been attributed to both the French Bureau brothers and François Surienne, the Burgundian Captain of Artillery. It was certainly a system in use by the third quarter of the 15th century. With the

gun fitted with a trunnion, fitting the gun into a wooden bed was unnecessary as the recoil would be absorbed by the carriage.

The trail of the gun could be either solid or made of two cheeks with the gun mounted between them. Over the touchhole or between the trails of the gun could be placed a useful lidded box. I assume that it would contain those essential items that the gunner requires, such as prickers, linstocks, spare match, flint steel and tinder, and possibly even some immediate-use ammunition. The gun tools, mops, rammer and powder scoop seem to have been tied over the barrel for transport and ready use.

A pair of trunnions have been welded onto a wrought-iron stave and hoop-built gun in the Tojhusmuseet. The assumption that only cast guns could be fitted with trunnions is clearly incorrect. (Author's collection)



The collection of artillery captured at Grandson and Murten in western Switzerland show a wide range of different guns and carriages at what was a turning point in the history of field artillery, where the older pieces, wrought iron and mounted on pivoting beds, are alongside guns fitted with trunnions on 'modern' carriages. The artillery train of Charles the Bold of 1474 records all the carts needed for the transport of ammunition but only the number of horses required to pull the other guns, which would mean that most artillery was now mounted on carriages on which they could both travel and fire

The universal form of transport for ammunition and stores was the four-wheeled cart. The detailed figures that are available from Henry VIII's reign show that in principle each cart would have two carters and seven horses and was rated at 1½ tons (1,524kg). In practice, bills of lading suggest that a cart carried only 816kg of powder or shot.

Speed of movement depended of course very much on the roads and the weather. The Burgundian siege train to Calais travelled at between 11 and 20km a day, which would have enabled it to keep up with most medieval armies. For larger guns, significant preparations had to be made by repairing roads and reinforcing bridges, which is why siege trains were so often accompanied by large numbers of sappers and carpenters, as recorded in the siege train of the Duke of Burgundy of 1475.

Field fortifications could be constructed in preparation for battle, as at Murten and Northampton, and were essential at a siege where counter-battery fire from defensive artillery was to be expected. Mantlets, or heavy shields of wood, provided a stalwart defence against all bolts and arrows and small-calibre projectiles. A swivelling mantlet allowed a gun to be exposed to enemy missiles only when it was fired. Christine de Pisan provides a detailed description of such items:

First, six large mantelets for the large cannons ... fashioned on an axle with supports, each of them ten or twelve feet wide, thirty feet long and a handsbreath thick.

Ten other smaller mantelets, each of them twelve feet long and eight to ten feet high ... each will have a window for firing the cannons when necessary. The board will in general be four inches thick, and each will be on two wheels like carts, made of light boards more or less an inch thick.

It would seem sensible to have prefabricated such large and complex structures beforehand, all part of the preparations necessary for a successful siege.

Commonly seen in contemporary illustrations are gabions, large open-ended wicker containers that would be filled with earth, providing very effective, cheap and rapid cover from enemy fire. Further protection could be provided by a large wooden shield known as a pavise, along with strong wicker and leather panels.

This confused and busy picture of a medieval building site is a helpful guide to the equipment that would be essential for the transport and emplacement of medieval siege artillery. All artillery trains were accompanied by labourers or pioneers who would make or re-make roads, strengthen or even build bridges and then emplace the guns behind fortifications of wood and earth. Carpenters and blacksmiths were as vital as the gunners themselves on a campaign. (Burgerbibliothek Bern, Mss.h.h.I.16, p. 545)



The destructive power of artillery fire is highlighted here. The importance of such a bombardment on morale should not be underestimated. Destroying the will to resist of the garrison and the civilian population could be more important than demolishing their walls. Despite a heavy artillery barrage this siege will prove expensive for both attackers and defenders. (Burgerbibliothek Bern, Mss.h.I.16, p. 169)



CANNONS IN COMBAT

Siege guns

Although it took some time, by the beginning of the 15th century the trebuchet was being replaced by cannons as the principal means of breaching walls. But what precise effect did artillery have on siege warfare? It seems unlikely that Milemete-type cannons would have had any impact on the stone walls of a castle in 1326. In 1347, Edward III assembled a force of artillery outside the walls of Calais, but the outcome was decided by starvation of the population and the failure of the French army to come to their aid rather than firepower. Sir Charles Oman, the grand old man of military history, has opined 'that the triumph of artillery only commences in the middle years of the fifteenth century'.

While powder was still prohibitively expensive and even the largest pieces therefore comparatively small, it was unlikely that they would be able to perform a 'wall-busting' role. The development of domestic saltpetre plantations led to the tumbling of gunpowder prices and castle walls. The first victory proclaimed by historians was the capture of Saint-Sauveur-le-Vicomte by the French in 1375 using bombards capable of shooting balls weighing up to 45kg. The *Chronique du Religieux de Saint-Denis* records that at the siege of Bourges the bombard named *Griette*:

shot stones of enormous weight at the cost of large quantities of gunpowder and much hard and dangerous work on the part of its expert crew. On the first day, the foundations of one of the towers was partly demolished by a direct hit. On the next day this cannon fired twelve stones, two of which penetrated the tower, thus exposing many of the buildings and their inhabitants.

The impact on the defenders' morale could be more damaging than that to the walls. At the siege of Harcourt in 1449, a single shot was enough to cause surrender. In 1405, at the siege of Berwick, Thomas Walsingham recorded that the first round fired demolished part of one of the towers and 'so frightened the garrison that they preferred voluntarily to expose themselves to the king's swords rather than to wait for a second firing'.

At the siege of Ham in 1411, again that impressive bombard *Griette* forced the surrender after only three rounds were fired. The first went over, falling in the River Somme, the second destroyed a tower and adjacent walls and the third breached the wall. The bombardments need not be so short and could be impressive in scale, as at Harfleur (see below) or at Dinant in 1466, when 502 large and 1,200 small gunstones were fired at the town in one week.

Remarkable and apparently uniform success for this new super-weapon should be set against examples of abject failure, sometimes easily explained. At the siege of Beauvais in 1472 by the Lord of Cordes, two cannons were provided with only two gunstones. After making a large hole in the gate, the besiegers were forced to cease fire and withdraw. Guns without ammunition are useless, a lesson which should have been learned by then.

In the suppression of the Welsh rebellion led by Owain Glyn Dŵr, Aberystwyth and Harlech castles were besieged by Henry IV, accompanied by a substantial artillery train. The Welsh garrisons maintained a prolonged and successful resistance until finally starvation rather than bombardment forced them into submission. The cost to the besiegers in ordnance was considerable.

The successful and much-lauded siege at Saint-Sauveur-le-Vicomte was achieved with only two cannons initially, to be joined by two more with additional supplies of powder. These guns were apparently unable to damage the towers, although one shot entered the window of the bedchamber of the English garrison commander, causing him some consternation as he was in the bed at the time. The siege was finally decided by the French paying the English garrison 55,000 gold francs to withdraw, hardly something that they would have contemplated if the French artillery could have achieved a less costly outcome.

The siege of Harfleur in 1415 by Henry V saw an impressive siege train, on this occasion well supplied with ammunition and emplaced against substantial and well-prepared fortifications. The expenditure of ammunition was prodigious, with on average 286 rounds fired against the city every day. Yet it was not the deluge of gunstones but the failure of a relieving force, allied to a fear of the murder and rapine that would follow its capture, that led to surrender. Gunpowder

Although it might seem obvious, a tower or wall should preferably be struck at the bottom. Nibbling the wall from the top down was far less productive. The taller the wall, the easier it would be to destroy. The massive thickness of some fortifications and the use of natural rock outcrops as a foundation could make the cannoners' job frustrating. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.019r)





A busy siege in progress with evidence of a bronze wheeled gun, a bronze bombard and what is probably an iron mortar. Powder, shot and loading tools can be seen. The besieged have reinforced their walls with wattle hurdles and wooden barrels, no doubt filled with earth to give protection against small-calibre shot. (Burgerbibliothek Bern, Mss.h.I.16, p. 637)

artillery was undoubtedly a key factor in deciding the outcome of the sieges, but not necessarily the key one.

In 1418–19, Henry V did not employ artillery at the siege of Rouen, the capital of Normandy. This decision requires some explanation, as Henry was continuously adding to his stocks of weapons and powder during the campaign. It was clear that a city with no hope of relief by a French army would certainly have to surrender at some point, and that the expensively caused physical damage to the city would have to be expensively repaired. These were powerful arguments for not deploying artillery against what was intended to be a major base for his forces in France.

The loss of England's possessions in Normandy has been attributed to the Bureau brothers and the French artillery train. The short durations of their sieges (Caen 17 days, Bayeux two weeks and Rouen just three days) is a testimony to the overwhelming might of their siege and field forces, which made resistance useless. The siege of Cherbourg could have

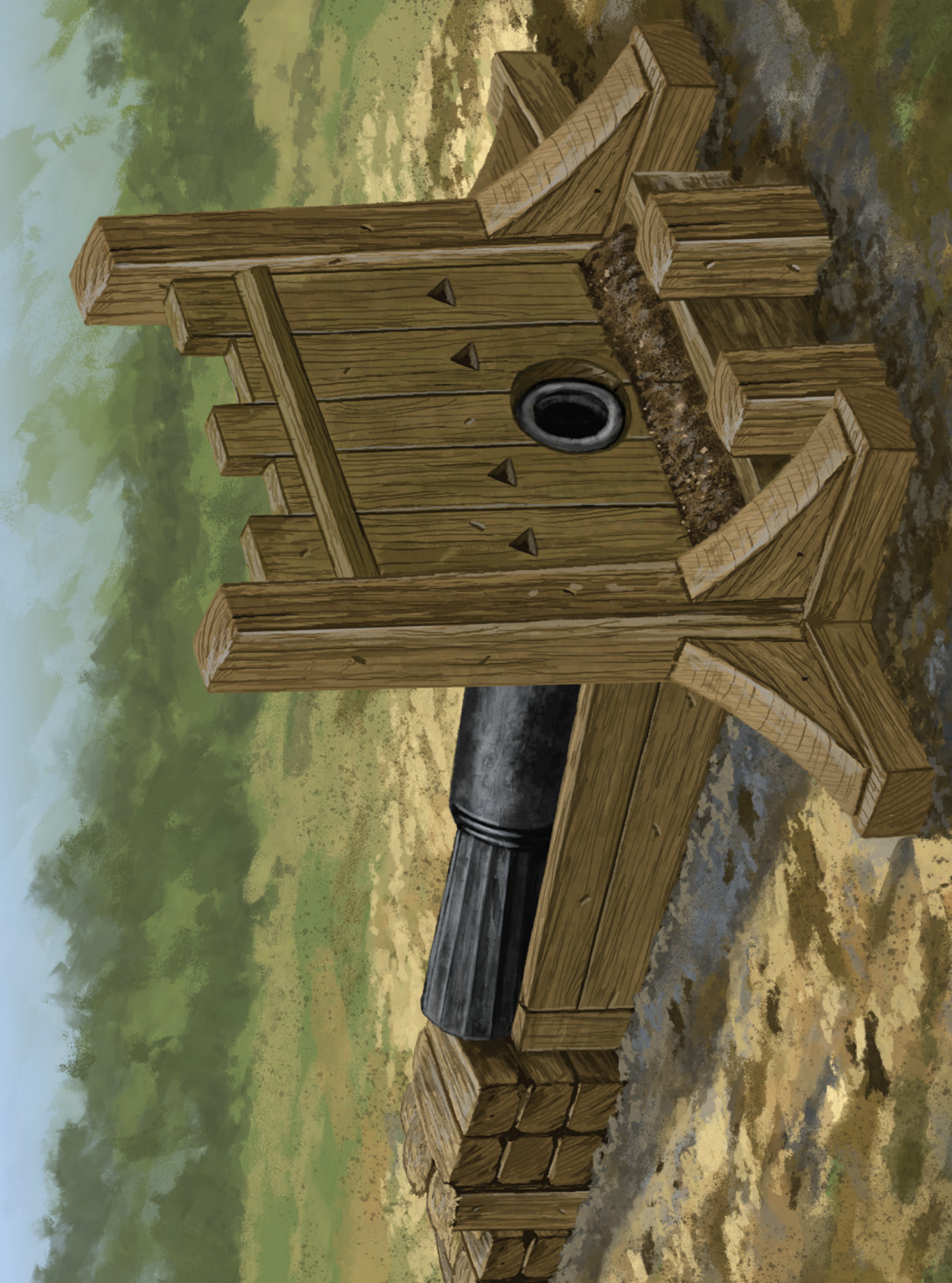
been shortened if they had not insisted on siting one siege battery on tidal flats, allowing the guns to be inundated twice each day. These submerged pieces were 'protected' by tallow and hides, but perhaps not as effectively as was hoped, as three bombards and a cannon burst during the siege.

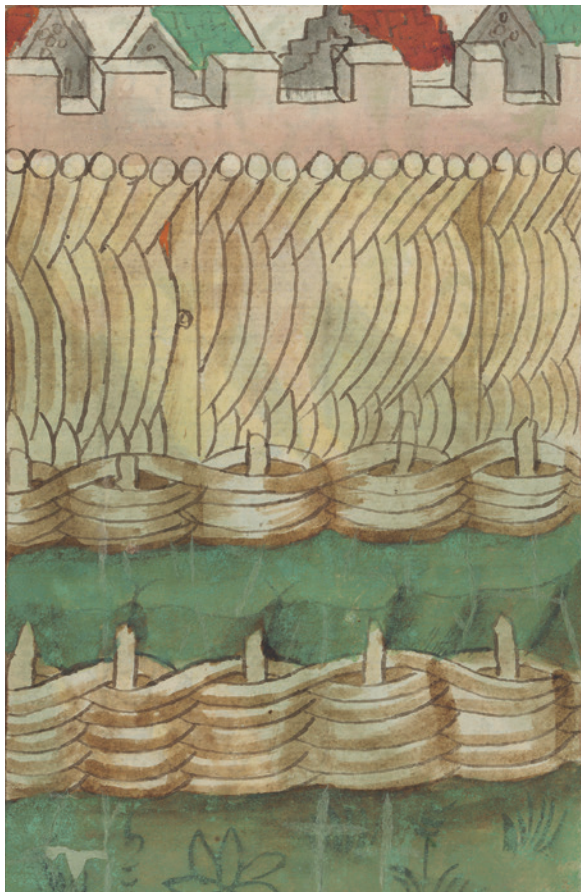
It was not always so easy to achieve a rapid result, as in the example of Bordeaux. On this occasion Jean Bureau foolishly promised its speedy destruction, but it lasted out a three-month siege before reaching favourable surrender terms. Undoubtedly the Bureau brothers and their bombards and veuglaires, mantlets and shovels drove out the English, but that principally reflected the superior political, economic and military condition of France.

E

SIEGE OF HARFLEUR, 1415

At the siege of Harfleur, Henry V's army was equipped for the first time with a large array of gunpowder artillery. This made him the first English monarch to fully appreciate the possibilities of this new weapon. Henry developed an efficient administration and ordered the construction of a wide range of ordnance. Nicholas Merbury was made 'master of the works of the king's engines and guns and other ordnance' in 1414, effectively becoming the first Master of the Ordnance. William Van Jsendorne, a Dutch knight, was appointed to recruit some 29 master gunners and double that number of gunners, many of whom, judging by their names, were from the Low Countries or Germany. The employment of gunners from these regions was common across Europe, as their expertise was universally recognized. In addition to these gunners, the artillery train included 120 carpenters, 100 mason and 60 carters. The carpenters constructed the gun mounts and recoil timbers for the guns, as well as the mantlets, substantial wooden structures in their own right. In the case of some of these, 'the bottom was lifted up so as to give a view of the town until, a target having been selected, the guns from immediately behind them discharged their stones by the explosive force of ignited gunpowder'. The bombardment used some three-quarters of the stocks of ammunition, including approximately 10 tonnes of gunpowder. The impact on the poor defenders was truly terrible, with Thomas Walsingham reporting that, 'the huge force of their [guns'] blows smashed everything that got in their way as they landed, not only killing the bodies which they flattened, but also scattering around whole, bleeding limbs.'





Most medieval illustrations of sieges show the curtain walls and towers, but little else. Here, wood and wattle external fortifications have been added. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.149r)

Besieged guns

If gunpowder weapons could be used offensively, they could also be used defensively. Gun loops, specifically for small-calibre gunpowder weapons, appeared in England and France from about 1365 and 1380 respectively, and later in Germany, Italy and Spain. Paris was not equipped with gunports until 1415. We can assume that up to this date gunpowder weapons of small calibre could well have been used within existing fortifications. Gunports were usually shaped like inverted keyholes or barbells, which meant that only the smaller-stocked weapons could be used.

Incorporating firearms in defence was one response; the other was to reinforce the existing walls with masonry or compacted earth, as well as constructing a deflecting surface or glacis on the exterior. More resilient construction materials could be used: for example granite at Fougères in Brittany, sandstone at Haut Koenigsbourg in Alsace and brick at Kirby Muxloe, Leicestershire. If walls could not be reinforced, then moats, wet or dry, could be widened, but again this was expensive and not always possible.

Additional fortifications could be constructed to take advantage of the new weapons and provide greater protection for the older defences.

To protect the tall outer walls from direct fire, an outer fortification known as a bulwark could be constructed, as was done at Harfleur in readiness for the English assault in 1415. It was a circular fortification which used large tree trunks on the outside, 'almost up to the height of the town walls', which were reinforced with earth and wood on the inside. Although subject to a sustained bombardment, it proved easy to reinforce the day's damage at night with more earth, wood and stones. The brave defenders continued to resist in the chaos left by the bombardment, 'as long as these were defensible ... and afterwards from the ruins, behind screens, gaps in the walls' and 'from other places where shelter would have not been thought possible'. Inside the town itself, the streets were covered with material such as earth, clay and dung to absorb the impact of incoming fire.

A simple low earthwork defence, well-provided with gunpowder weapons and known as a boulevard, was also an attractive possibility, both militarily and economically. These were used by the English at Orleans and Poitiers and extensively by the French at Gisors and Avignon. This projecting fortification providing useful crossfire, low lying and constructed from earth, was in many ways the precursor of the *trace Italienne*, the developed system of fortification that would dominate siege warfare for centuries. It was the boulevard built by the English outside the Tourelles gate at Avignon which defeated sustained French attacks with heavy losses during the famous siege of 1429.

One of the most obvious and effective applications of gunpowder weapons to defence was to be found in the artillery tower. A simple circular fortification, although other shapes could be used, it provided massively thick walls to defend the guns and their crews. The French tower built at Ham was 33m in diameter and the same in height. In Norwich, Cow Tower had walls built, rather unusually, with a brick facing to a mortared flint rubble interior. Fifteen metres high and fitted with splayed gunports as well as arrow loops, it was built in 1398–99 to defend the approach to Bishop's gate over the River Wensum.

Piecemeal additions and alterations to defences could only partly defend against gunpowder weapons or take advantage of their potential. It was in Italy that the form of defence that would come to dominate siege warfare, the angled bastion, developed. As early as the 1440s, Leon Battista Alberti had recommended that:

The wall should be flanked by towers acting as buttresses every fifty cubits. They should be round, standing out from the wall, and somewhat taller, so that anyone venturing too close would expose his flank to missiles and be hit; thus the wall is protected by the towers and the towers by each other.

He also recognized the importance of 'soft' material for absorbing the impact of artillery. His towers were to be 'filled with a mixture of clay and straw, and packed down. Thus the softness of the clay will deaden the force and impact of the engines.'

Guns at sea: Northern waters

War at sea took many forms: sea battles were rare events indeed, but not unknown. More commonly, ships were used for the transport of men and equipment or to sustain a land force, relieve a blockade or take part in commerce raiding. If large numbers of ships were required, civilian ships would be hired or requisitioned. Warships as a distinct form were effectively unknown throughout most of this period, as all ships could perform that role if required.

Sea battles were a watery version of land battles. They might begin with a barrage of missiles, using cannons, bows and darts thrown from the crow's nest, but the vessels were then set alongside each other, anchors dropped and a melee would ensue, where cannons fixed at the hull side would be more or less useless. Ships in themselves were valuable items, one of the most complex and expensive machines produced in the medieval period. Their destruction and loss were anathema and the preferred outcome of any battle was their capture, which could only be achieved by boarding vessels or by so outmanoeuvring them to force them to surrender.

In this illustration of a sea battle in the Beauchamp Pageant can be seen the principal missile weapon that proved so decisive at Sluys in 1340, the bow. Two guns are shown peeking over the gunwale of the ship to port. Characteristically, they both have foresight rings fitted to their muzzles. The impracticality of their position would suggest that the artist chose to include them without correctly placing them on the deck, where they would have been invisible to the viewer. (British Library, London, UK© British Library Board. All Rights Reserved/Bridgeman Images)



Late medieval ships' guns in the Tøjhusmuseet. Chambered pieces such as these were ideally suited to shipboard mounting as they obviated the need for muzzle loading, requiring the gun to be drawn inboard, which would have been difficult at sea. (Author's collection)



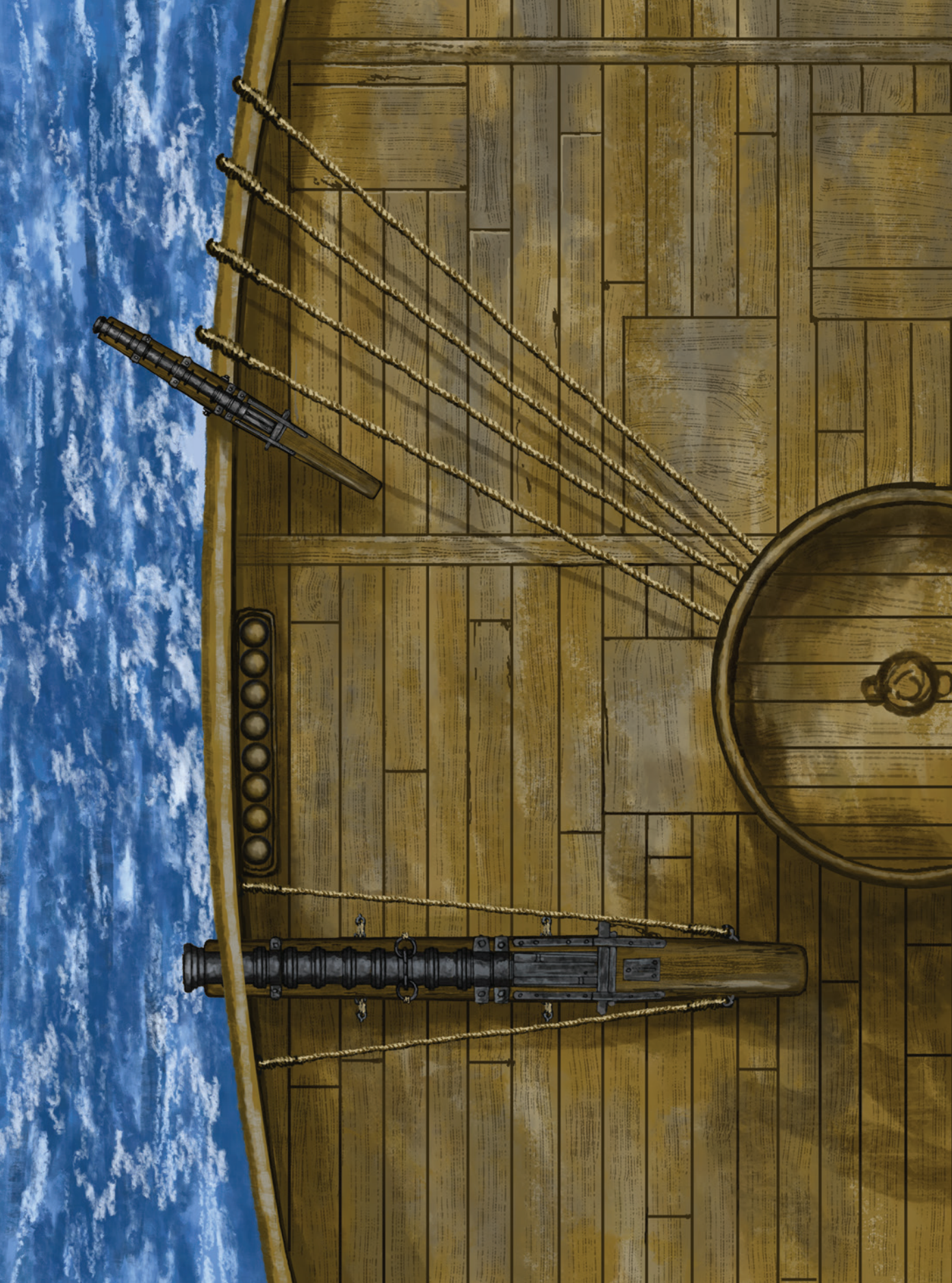
The first reference to gunpowder weapons at sea is to the *All Hallows' Cog*, which was refitted in 1337–38 with 'a certain iron instrument for firing quarrels and lead pellets, with powder, for the defence of the ship'. With such an early date for the appearance of gunpowder weaponry at sea, it is surprising that at the battle of Sluys in 1340 there is no reference to artillery playing a role. Aggressive leadership, competent seamanship and the power of the longbow seem to have won the day on that occasion.

Susan Rose writes in *Medieval Naval Warfare* that, 'Although cannon were undoubtedly carried on ships it is hard to find any action where their presence made a definite contribution to the outcome.' In the major engagement outside Harfleur in 1416 when the French blockade was broken, cannons appear to have played no part worth mentioning, although Henry V's most

F

GUNS AT SEA

There were many good reasons for not wishing to take guns to sea. Firstly they would take up valuable space, whether stowed in the hold or on deck, and secondly all sailors quite rightly had a horror of fires at sea. The carriage of gunpowder was a constant danger, especially in action. The third and perhaps most important reason was the hygroscopic quality of gunpowder: like all salts, it readily absorbed water from the atmosphere, rapidly becoming at best unreliable and at worst useless. An attraction of the separate breech system was that it could be kept loaded and 'sealed' ready for use. Powder casks would have to be carefully protected from damp, which was not an easy task, especially on small vessels. The preponderance of bows, crossbows and 'darts' in ships' inventories would suggest that these were of more use in the form of warfare that predominated: a sharp exchange of missiles and then boarding. The evidence from the *Newport* ship suggests that even a merchant vessel, engaged in the Portuguese trade from Britain in the 1450s and 1460s, could carry a substantial armament of gunpowder weapons, as depicted here. The largest cannon ball found on board is some 102mm (4in) in diameter. A gun of that calibre, known as a *slange* (snake) in Denmark, or a sling or serpentine in England, was found off the north-west coast of Anholt and is at present in the Tøjhusmuseet. The length of its barrel, including breech, is approximately 1.89m (6ft 6in) and it has an overall length of 3.2m (10ft 6in), not a small piece to manage aboard ship. There is circumstantial evidence to suggest that the ship may have belonged to the wealthy Earl of Warwick, who had gained great kudos from controlling the Channel and reducing the endemic piracy that preyed on English vessels.





This splendid illustration from the *Schilling Chronicle* shows a rather haphazard distribution of guns on the larger ship. More importantly, the small rowing vessel has been fitted with a bow gun, as galleys would have done. The bronze gun on an adjustable mounting fitted as a bow chaser in the larger vessel may have been practical in a vessel without a foremast and bowsprit. (Burgerbibliothek Bern, Mss.h.h.I.16, p. 586)

six chambers and 72 gunstones. The 29.5kg of powder on board would provide for a charge of significantly less than 0.5kg per shot, giving them a gunstone of about 2.3kg: not in any sense a 'ship-smasher'. The 'Newport ship', dateable to about 1450–70, was found to contain gunstones of 2.5in, 3.5in and 4in in diameter (65mm, 88mm and 102mm); the 4in shot would weigh approximately 1kg, or something over 2lb. These were anti-personnel weapons incapable of sinking a ship.

There was a major increase in the number of guns mounted aboard ship by the end of the century. The *Grace Dieu*, built in the 1430s, had an armament of 21 guns with 89 chambers by 1485, whilst the *Edward Howard* of 1479, a three-masted ship and probably a carrack, was provided with 15 guns with 64 chambers. Perhaps more significantly and indicative of the tactics to be employed at the time, the old *Grace Dieu* was provided with 140 bows, 810 sheaves of arrows, 140 bills and numerous axes, crossbows and other hand weapons.

The number of guns in the warships of Henry VII would suggest that they were in the majority small-calibre chamber pieces. The *Regent* in 1497 boasted 181 guns identified as serpentines, provided with 453 chambers. All almost certainly mounted on 'miches' or swivels, indicating that they were only anti-personnel weapons. The *Sovereign*, built in 1488, had 110 serpentines and 31 stone guns, the latter organized with 20 on the weather deck and the remainder in the stern castle. The *Anthony of London* boasted of one large gun, a curtowe, firing a 5kg stone shot, as well as 57 smaller pieces. The curtowe would have produced significant damage to any contemporary vessel, which leaves one wondering why more such guns were not mounted?

Early guns were all fixed onto or into wooden mounts, which were heavy enough to absorb the recoil when fired. Lighter guns could be shot resting on the gunwale – the strengthened portion of the hull's sides. Heavier guns resting on large wooden mounts could only be mounted on the weather deck, the main deck open to the weather between the forecastle and sterncastle. Smaller-calibre guns could be mounted in or on both castles, but the mounting of larger guns would have affected the stability of the ship.

heavily armed ship, the *Holy Ghost*, was present, provided as it was with seven guns with 12 chambers. In this action it lost its boarding grapnel and chain, buoy ropes and anchor, indicating that during the action it was moored and alongside an enemy vessel.

This is not to say that firepower was unimportant; the numbers of guns increased, as did their size. Henry V, who created a significant naval force to exercise power overseas, had 15 gun-armed vessels with a total of 42 guns between them. The 600-ton carrack *George* had but three cannons with

If greater numbers of larger guns were to be mounted without adversely affecting stability, they would have to be placed below the weather deck. To do this, gunports would have had to be cut in the hull and fitted with tight-fitting lids, together with a means of opening and securing them. In Northern European and northern Iberian waters, ships were clinker-built. The strength of the clinker-built ship was found in its overlapping planking, not in the ribs or framing found inside the hull. If ports were cut into the planking they would seriously affect the structural integrity of the whole vessel. Without gunports in lower decks there could be no increase in the number of heavy guns.

Guns at sea: the Mediterranean

In the Mediterranean, the warship par excellence had always been the galley. Fast, manoeuvrable and of shallow draught, it could land troops ashore or seek safety in shallow waters. It was considered an expendable item, as the principal cost was not the vessel but its operation, due to its large crew of sailors and soldiers. By the 14th century, almost the ideal form of the galley had been developed, the trireme *alla sensile* ('in the simple fashion'). The mode of warfare was offensive, although the ramming beak had long been replaced by what was now a boarding beak, designed to smash into the enemy vessel and secure it as the soldiers and oarsmen boarded. A fighting superstructure could be fitted above the bow, acting in a similar way to the forecastle on Northern European vessels.

Oars and oarsmen took up almost all the deck space, and what was left was used for the galley (kitchen) and the ship's longboat. The bow behind the



Providing a wooden mount for artillery with wheels was a logical step. Guns such as this one would still need to be transported on carts, as the carriage was unsuited to movement over any distance. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.046v)



The Middelaldercentret has reconstructed a field gun illustrated from a medieval manuscript. Its purpose was to combine firepower and manoeuvrability. Although a dead-end in terms of development, it was one of many ideas that would ultimately produce the field gun that would remain virtually unchanged until the mid-19th century. (Courtesy of the Middelaldercentret)

boarding beak, on the other hand, was ideally suited to mounting a gun, without there being any necessity for structural alterations. The main centre-line bow gun was mounted on a rigid timber bed and the bow itself was already structurally strong as it was designed to absorb the impact of ramming another vessel.

There is very little evidence for the use of gun armaments on galleys until very late in this period. There is a tantalizing reference to a Burgundian galley of 1445 which had an armament of five veuglaires, 1.2m long with a 10cm bore with fifteen interchangeable chambers, as well as two mounted coulovrines and 12 hand-held coulovrines. Despite what appears a formidable gunpowder armament, what precedes it in the inventory are the heavy and light crossbows. There is one illustration in a German woodcut dated to 1486 which provides some evidence of what appears to be a powerful wrought-iron gun fitted in the bow.

Documentary evidence records that in 1481 the Real, or royal, galley of Alfonso the Magnanimous, mounted two bombards, whilst the Real of Ferdinand of Aragon in 1506 mounted a much heavier armament. This included a bombard weighing 1,978kg shooting a stone ball weighing 36kg, two cerbatanas each weighing 1,134kg shooting stone balls of 11kg, and a pasavolante weighing 680kg shooting a ball of 4.5–5.5kg. Such vessels sitting low in the water would be a small target but possess a devastating punch that would strike low on their opponent's hull, making them real potential ship killers. It would be in the 16th century that the cannon-armed galley would come to dominate warfare in the Mediterranean.

The use of carriage-mounted firearms, field guns and deep ditches that would stop an enemy approaching was a sound strategy, although the enemy could use his own artillery to besiege the extemporary fort. A bear would come in handy as well. (Burgerbibliothek Bern, Mss.h.h.1.3, p. 846)

Field artillery

Although gunpowder artillery replaced the trebuchet in sieges, it did not change the fundamentals of siege warfare. On the battlefield, gunpowder artillery certainly appeared quite early, but here too it did not change the nature of battle. Why was this the case?



The first battle where it might be said that gunpowder weapons proved crucial in deciding victory was at Bevershoutsveld in 1382, between the good burghers of Ghent and Bruges. The Ghentenaars brought some 300 gunpowder weapons, no doubt mostly of small calibre, to a camp outside Bruges. The Brugeois, who at that time were celebrating the Procession of the Holy Blood, drank freely of a more alcoholic liquid, and filled with both kinds of spirit they rushed out to sweep the men of Ghent from before their walls. On receiving a single massive volley from the multitude of guns, the Brugeois attack stalled and then became a rout. Whether this victory was mostly due to the effect of gunpowder weapons or the ill-effects of alcohol, lack of leadership and poor discipline, it would be difficult to say.

If Bevershoutsveld was farce, then Castillon was pure tragedy. In 1453, an English force led by Lord Talbot was attempting to relieve the siege of another English force at Castillon. The French besiegers, organized by the Bureau brothers, had constructed a very strong field fortification, behind which they had massed a wide range of firearms large and small. Talbot, who was unarmoured and unarmed as he had previously sworn not to bear arms against his former captors, saw the withdrawal of French troops and sought to turn this into a rout. In fact the fortifications were fully manned by a determined garrison. Talbot's archers and men-at-arms found themselves facing an impossible task as they were not equipped for what was in practice a siege, and were mown down. While this great victory over the English forces could be seen as the first real triumph of firepower over the English longbow, in fact it was nothing of the sort – it was a tactical misreading of the situation which led to the English archers being slaughtered.

Perhaps the most extraordinary story in the medieval history of gunpowder weapons was written in Bohemia. It was here in the early 15th century that Jan Ziska led the rebellious heretical Hussites against their noble overlords and neighbours through the use of the Wagenberg, or wagon castle. The transformation of the carts used for transporting an army into a curtain wall to defend it was nothing new; it was common practice in Russia and Lithuania. What Ziska did was to turn what was essentially a simple defensive measure into an offensive one. By equipping his reinforced carts with firearms and crossbows, he turned them into a stout defence against which a force of noble cavalry could deplete and exhaust itself. By assuming correctly that he could rely upon the aggressiveness of his noble opponents, as Henry V did at Agincourt, and by providing a ready means of egress for his infantry and cavalry, he could turn the defeat of his opponents into a rout by launching an attack when his opponents were exhausted and demoralized. This strategy was hardly transferable across Europe as to be successful it



This photograph from the Heeresgeschichtliches Museum (Museum of Military History) in Vienna shows a howitzer barrel fitted to a field carriage provided with an elevating arc. Such guns gave the late medieval army an effective form of firepower that could complement, if not fully replace, bows and crossbows. (Author's collection)

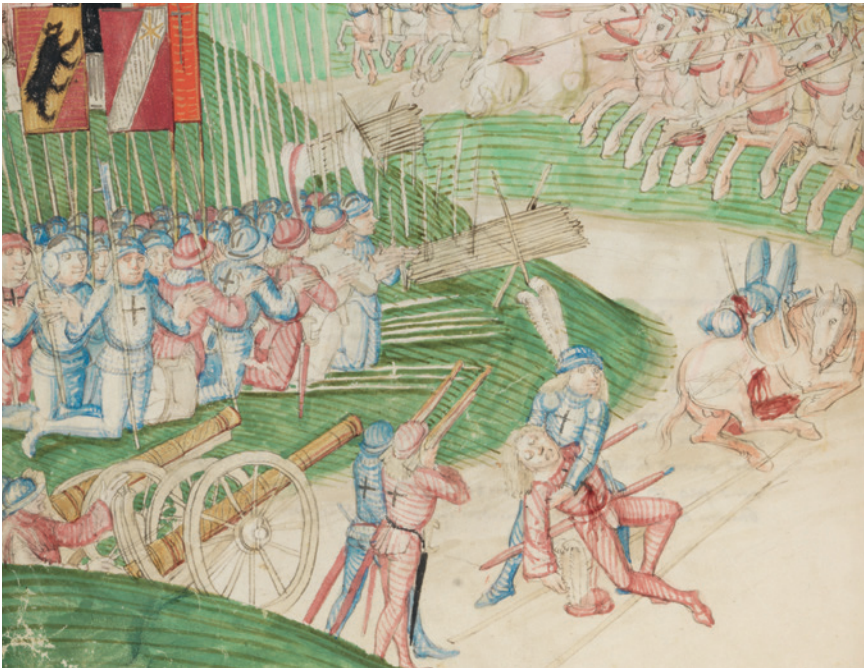


Guns captured at the battle of Murten in 1476. This extraordinary collection shows the key technology of the period that would produce the 'traditional' field gun. On the far right is a breech-loading wrought-iron gun set on a wooden bed, which could be elevated using the elevation arc. Next to it is a wrought-iron gun stave-built piece fitted with trunnions and a trail made of two cheeks, enabling the barrel to be elevated and depressed. It was converted to muzzle loading, as were several of the captured Burgundian examples. The third has all the appearance of a 16th-century field gun: the barrel is of wrought iron, although it looks like a cast gun. (Image courtesy of Charles Ballif)

depended upon an unhindered space for the masses of carts to manoeuvre. It did see two new pieces of artillery which grew from the demand for more firepower: the tarasnice, or large trestle-mounted gun, and the howitzer, a short-barrelled cannon mounted on a field carriage.

If Castillon ostensibly provided a pattern for the successful employment of artillery 'in the field', the battle of Northampton in 1460 proved otherwise. The Lancastrian forces had fortified a strong position with ramparts, ditches and moats which was well provided with artillery. The son of the unfortunate Talbot was one of the Lancastrian leaders, and he might well have been at Castillon with his father and hoped to do to the Yorkists what had been done to his father. There is agreement that artillery played little or no part in the defence. An *English Chronicle* reported that 'the ordnance of the king's guns availed not, for that day was so great rain, that the guns lay deep in the water, and so were queynt and might not be shot'. Wavrin, however, records that 'the cannoneers through evil cowardice had not put stones in their machines, wherefore when they put the fire in they only shot the wads'. On the Lancastrian side, Lord Grey turned his coat at the moment the Yorkists reached the fortifications and helped them in, which was probably the key to explaining the defeat.

A more significant role played by artillery occurred at Formigny, another English defeat, on 15 April 1450. An English force was attempting to open the road to Caen that was being threatened by the French Royal Army. An army under the Count of Clermont numbered some 3,000, including men-at-arms, crossbowmen and some local infantry, and as artillery support he had two culverins. Sir Thomas Kyriel and Sir Matthew Gough, facing Clermont's force, took up as usual strong defensive positions reinforced with stakes and a trench. After some hours of skirmishing and indecisive French attacks, Giraud, the 'master of the royal ordnance', placed his two culverins to give enfilading fire on the English forces. The archers, facing what was clearly galling artillery fire, broke ranks and overwhelmed the French battery and its defending infantry. The English infantry, who were attempting to drag back the French artillery, were set upon by a large body of French men-at-arms. The rolling melee that ensued enveloped the main English line of battle, the archers being unable to contribute to the struggle without killing their own comrades. The arrival of a sizeable French force of over 1,000 men now overwhelmed the main English battle line. Gough made his escape to Bayeux, but Kyriel and the remainder of his force was slaughtered. The battle was lost



A rare illustration of field guns in action on the field of battle. Trials conducted by the Company of Saynte George suggest that a high rate of fire and considerable accuracy could be achieved with wrought-iron breech-loading guns. Burgerbibliothek Bern, Mss.h.I.3, p. 644

through bad generalship and bad luck, but artillery did play a significant part in changing the course of the action and it also showed that artillery, when handled with some imagination, could produce serious casualties on infantry.

The battle of Bosworth in 1485 has gained considerable importance for military historians and archaeologists recently, as with the discovery of the site has come the unearthing of the largest collection of medieval cannonballs, some 40, which is as many as the total number discovered elsewhere. Recent *Time Team* trials have shown that when fired, the balls strike the ground and then bounce and skip some hundreds of paces more, a characteristic well known and exploited by gunners for centuries. Richard III undoubtedly 'outgunned' Henry VII's force as he was supported by the royal ordnance from the Tower of London, yet victory did not come to the bigger battalions or batteries. Henry's forces refused to advance against the well-chosen and powerful position of Richard, forcing Richard to engage with him. The battle was not decided by firepower, but ultimately by the treachery of the Stanleys, who switched to Henry's side at a crucial time.

The use of artillery in the reign of Charles the Bold of Burgundy is instructive as he was an enthusiastic proponent of artillery and had the means to pay for it. At Grandson in 1476 he lost principally because his artillery, carefully emplaced, was facing the wrong way and was overrun after a feigned retreat turned into a rout. After losing all his artillery, he faced the Swiss again that same year at the castle of Murten/Morat, where his siege lines were protected by a new force of artillery drawn from stocks in his ducal possessions. On this occasion the failure of the Swiss to attack when expected led him to allow his army to return to its tents, and when the Swiss appeared, despite a brave attempt by English archers to hold the line, the gun line was overwhelmed and the Burgundians driven into the lake beyond the castle. His final defeat was in 1477 at Nancy, where he lost his life as well as his remaining guns. Outnumbered by the Swiss and their allies, he had again



Light artillery such as this were both common and effective. Similar guns were used by the Hussites with great effect against infantry and cavalry, as the *Wagenberg* (wagon castle) gave the gunners and their pieces protection from direct attack. Similar guns were useful anti-personnel weapons aboard ship. (Zentralbibliothek Zurich, Ms Rh hist 33b, f.070r)

prepared a strong defensive position which his opponents outflanked. His artillery and hand-gunners played little part in the battle, and he and his army were massacred.

During the 14th century, the high cost of the propellant meant that guns were small and of limited effectiveness on the battlefield. The Loshult cannon could replace the springald in the defence of a castle gate, but could achieve little more. This does not mean that they did not appear on the battlefield; cannons almost certainly did at Crecy, and despite claims that they forced their enemy to flee in panic it appears unlikely, another attempt to find an excuse for what was a failure of French generalship and lack of discipline.

As important as technological weakness was a refusal by those in command to see artillery or gunpowder weapons as being of any great significance. Costly and noisy, they were seen only as an addition to the conventional firepower of an army. Christine de Pisan, who wrote in 1400 with the authority of someone who had conversed with the military experts of the time, asserted that when drawing up an army the men-at-arms constituted the real strength and

‘in wing formation at their sides the firepower, cannoneers along with crossbowmen and archers similarly arranged’. It is especially telling that Henry V, the son of an artillery enthusiast and himself possessor of a large and impressive artillery park, did not see fit to employ a single cannon at the battle of Agincourt.

The reduction in the cost of powder and iron and the demands of warfare unsurprisingly led to a significant increase in the size and effectiveness of gunpowder weapons of all size, especially the bombard. It was in effect another form of siege. The use of field fortifications against which an enemy could batter himself to pieces was a tactic that would take advantage of the destructive force of artillery while protecting it from being overrun, and was used throughout the period. It was used without success at the battle of Northampton, and as shown above it was used on three occasions by Duke Charles the Bold of Burgundy and failed disastrously – eventually fatally for the duke himself.

By the late 15th century, artillery was certainly mobile enough to accompany an army to the field of battle and to be emplaced upon it. Once in position it effectively ceased to be mobile, as even if the gun itself could be moved it would be difficult to manhandle the powder, shot, loading tools etc. necessary for it to play its part.

By the last quarter of the 15th century, light artillery on mobile carriages could be a significant force on the battlefield, as it was at Formigny and Bosworth. However, it was not perceived as the potential king of the battlefield. When placed in the line of battle it could start the battle as the



These bronze muzzle-loading guns would equate to the 3-pdr regimental guns of a later era. Cartridges and shot are in ready-use chests and the gunners are adjusting their aim and priming their pieces. There would probably only be a single trained gunner for each small piece, plus three or four labourers or pioneers assigned to help move the gun and man it in action. A well-trained crew of four could achieve a rate of fire of two rounds a minute using such a gun. (Burgerbibliothek Bern, Mss.h.h.I.3, p. 21)

archers had done in initial volleys, but when the battle lines engaged it was in no position to play a larger part. Ultimately, success or failure on the battlefield was down to many factors, including morale, leadership and the weather.

CONCLUSION

Any technological revolution must be rapid and its implications profound. Although gunpowder weapons became commonplace within a generation of their appearance, they certainly did not revolutionize or even transform the nature of war. The recruitment and structure of armies remained relatively unchanged, as did their strategies and tactics. The trebuchet was replaced over time by the bombard, but the nature and duration of sieges remained the same. When artillery appeared on the battlefield, it was as an adjunct to existing missile weapons – increasing the slaughter, but changing little in how battles were fought.

If you seek the reasons for the decline of feudalism and the rise of the powerful nation state, then it would be better not to look for it in the foundry, forge or arsenal. It would be foolish to suggest that the sound and fury of artillery signified nothing. In its first two centuries, artillery certainly made war more expensive, created new logistical difficulties for commanders and added to the horrors of war, but did not fundamentally alter it.

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Cover image: The armour and halberds give a sense of scale to the imposing bombard placed in front. The large number of suspension points on the gun and attachment points on the mount are a good indication of how important it was to secure the weapon in action. The mount would give the barrel more than enough elevation, if it was to be used at the short range essential for both maximising accuracy and impact. (Sean McLachlan)

Author's Note

For anyone with an interest in medieval artillery I would recommend the following:

The Ordnance Society

The Ordnance Society is an international society with members from more than 20 countries.

Its primary aim is to provide a means of communication for individuals and organizations interested in any aspect of ordnance and artillery of all periods and to enable publication of their interests and researches. The Society organizes events and produces publications to further these aims.

The Middelaldercentret – Danish Medieval Centre

The Danish Medieval Centre is an internationally renowned living history museum that specialises in the meticulous reconstruction of many aspects of medieval life. The Centre has built an incomparable collection of impressive working examples of pre-gunpowder and gunpowder artillery. Many of the images and much of the inspiration for this book comes from the time I spent at the Centre.

A small selection of Museums with collections of artillery.

Tøjhusmuseet - Royal Danish Arsenal Museum, København, Denmark

Musée de l'Armée, Paris, France

Heeresgeschichtliches Museum – Museum of Military History, Vienna, Austria

Fort Nelson – Royal Armouries Artillery collection, Portsmouth, England

National Historical Museum of Artillery, Turin, Italy

Historical Museum of Artillery, St Petersburg, Russian Federation

Musée d'Histoire La Neuveville, La Neuveville, Switzerland

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